Project Final Report

West Monponsett Pond Nutrient Management Project
17-05/319

NTP: 1/11/17, Completed: 6/30/19

Town of Halifax, Massachusetts

Grantee's Project Manager: Cathy Drinan
cdrinan@town.halifax.ma.us

MassDEP Project Manager: Malcolm Harper
malcolm.harper@state.ma.us

PREPARED FOR:

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER RESOURCES

AND

US ENVIRONMENTAL PROTECTION AGENCY
REGION 1

MASSACHUSETTS EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Kathleen A. Theoharides, Secretary

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Martin Suuberg, Commissioner

BUREAU OF WATER RESOURCES
Kathleen M. Baskin, Assistant Commissioner

DIVISION OF MUNICIPAL SERVICES
Steven J. McCurdy, Director

A. Project Snapshot

Project Number and Title: Project 17-05/319, West Monponsett Pond Nutrient Management Project

A1. Project start date: NTP: January 11, 2017

A2. Date closed: June 30, 2019

A3. Basin and HUC 12 subwatershed: West Monponsett Pond / Taunton Watershed

A4. Segment and/or waterbody number(s): West Monponsett Pond, MA62119

A5. Status of waterbody (Category 5, etc.): 5

A6. Priority Pollutant(s) targeted: Total Phosphorus

A7. Estimated Annual Pollutant removal (quantity, not percentage)

N:

P: 614.8 lbs sequestered, 305 lbs in-lake reduction

Sediment:

Bacteria:

Other:

Method of Determination and calculations:

A8. **BMPs installed, number and type:** Application of aluminum sulfate in 2017, 2018 and 2019 in 232 acres of surface water in West Monponsett Pond to remove phosphorus from the water column.

2017 Dosing: 17 g/m^2, total of 33,162 gallons of aluminum sulfate and 16,762 gallons of sodium aluminate.

2018 Dosing: 10 g/m^2, total of 19,000 gallons of aluminum sulfate and 9,500 gallons of sodium aluminate.

2019 Dosing: 8 g/m^2, total of 14,561 gallons of aluminum sulfate and 7,301 gallons of sodium aluminate.

Two separate methods where used to estimate the phosphorus sequestered over a 10-year period. One method provided by DEP includes that 95% of the internal phosphorus load is sequestered. Based on an internal load of 293.5 kg, this results on a 10-year sequestration of **6,148 lbs** and an annual sequestration of **614.8 lbs.** Calculations are shown on the next page.

Sediment TP Sequestration				
Internal Load (kg/yr)	95% of internal load (kg)	Average Lifetime Alum Treatment 10 years-TP sequestration (kg)	Average Lifetime Alum Treatment 10 years-TP sequestration (lbs)	Optimistic Lifetime 20 years-TP sequestration
293.5	278.9	**2,788.6**	6,147.8	5,577.2

The other method of determining alum sequestration is as follows.

In laboratory results, 1 pound of aluminum will bind with one pound of phosphorus. In an aquatic environment, the ratio is closer to 10:1. Therefor by calculating the pounds of aluminum sulfate applied and divided by 10 will yield the amount of phosphorus sequestered.

Total determine the total weight, the combined dosing of 35 g/m^2 will need to be converted to pounds over the 232 acre dosing area of West Monponsett Pond.

Conversion factors used:

1 acre = 4,046.9 m^2

1 lb = 453.592 g

Calculations:

Dosing area in square meters: 232 acres x 4,046.9 m^2/acre = 938,880.8 m^2

Weight: 34.8g/m^2 x 938,880.8 m^2 = 32,673,051.84 g

Convert metric to standard: 32,673,051.84 g / 453.592 g / lb = 72,031.81 lbs

At 10:1 ratio, this equates to **7,203 lbs** of phosphorus sequestered

In-lake total phosphorus reduction post treatment is estimated at **305 lbs**. This is based on comparison of the pre and post treatment concentration of the phosphorus multiplied by the volume of the pond, calculations below:

In-lake TP reductions				
	Pretreatment	Post Treatment	In-lake TP Reduction (kg)	In-lake TP Reduction (lbs)
Lake Volume Litters	2610229466	2610229466		
Lake Concentration (kg/liter)	0.000000068	0.000000015		
Lake TP amount (kg)	177.4956037	39.15344198	**138.34**	304.9919

B. Descriptive Project Summary

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

SECTION 319 NPS PROJECT 17-05/319

PROJECT TITLE: West Monponsett Pond Nutrient Management Project
NPS CATEGORY: Implementation TMDL
INVESTIGATOR: Town of Halifax
LOCATION: West Monponsett Pond located in Halifax and Hanson, Massachusetts
TARGETED POLLUTANTS: Total Phosphorus

DESCRIPTION:

Monponsett Pond located in the towns of Halifax and Hanson, Massachusetts, is a significant ecological, historical, and recreational resource as well as an important supplementary water supply for the nearby City of Brockton. The 528 acre pond is bisected by Route 58, which splits the water body into two basins, East and West, directly connected by a small culvert in the Southern portion of the pond. Both basins are developed to varying degrees with residential homes and receive inputs from a suburban watershed of approximately six square miles. Cranberry bogs are also located on the western edge of the west basin and use the basin for irrigation purposes.

As a whole, Monponsett Pond has been heavily impacted by the use of its waters and watershed, and both basins have been listed as Category 5 "Impaired" waterbodies on the Massachusetts Integrated List of Waters (303(d) list). The East Basin was listed for nuisance aquatic plants and mercury in fish. A TMDL was approved by the EPA for mercury, thus removing the basin from the list of impaired waters. The Western basin appears on the 2014 303(d) list as a category 5 water body for excess algal growth, phosphorus, non-native aquatic plants and Secchi disk transparency. The West Basin was included in the mercury TMDL and a draft TMDL for phosphorus was released in November of 2016.

Both basins, especially the West Basin, have been subject to extensive nuisance algae blooms (specifically cyanobacteria – blue-green algae) for many years. During recent summers, these blooms prompted the frequent closure of the Western basin to swimming and boating. Algae testing has been carried out both by the Massachusetts Department of Public Health (MA DPH) and Massachusetts Department of Environmental Protection (MA DEP) throughout the summer months. MA DPH also conducted analysis of water quality, including total phosphorus. These results show a definite correlation between concentration of total phosphorus and total algal cell count in the Western basin throughout the summer. Previous testing and the TMDL have determined that internal loading of phosphorus is prominent in the West Basin, along with watershed loading.

Despite these water quality challenges, the Western basin has been identified as an area of priority habitat by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Program (NHESP).

C. Project Finances

Below are the original and 3 amendment project budgets. The original project budget, as applied for, was amended to allow for an additional alum treatments.

The total requested funds from EPA through the s.319 program for this project are $331,500.00.

This project had a total of 10 tasks, however, several of them were previously completed under separate phases. The following is a summary of the tasks included in this project:

ORIGINAL PROJECT BUDGET

West Monponsett Pond Nutrient Management Project
17-05/319

Expense Items	s.319 Amount	Non-Federal Match	Total Amount
Salary - By Title and salary range: Town Administrator $65-$70/hr Health Agent $30-$35/hr Conservation Volunteer $29/hr		**16,785**	**16,785**
Subcontractual Services: Engineering Services	$12,000	$8,000	$20,000
Phosphorous Inactivation Treatment	$87,000	$41,215	$128,215
Grant Management	$6,000	$4,000	$10,000
Subtotal:	**$105,000**	**$53,215**	**$158,215**
Other:			
Travel:			
Totals:	**$105,000** **60%**	**$70,000** **40%**	**$175,000** **100%**

AMENDMENT 1

Project Budget - Amended May 18, 2017

West Monponsett Pond Nutrient Management Project
17-05/319

Expense Items	s.319 Amount	Amendment	Non-Federal Match	Amended Non-Federal Match	Total Amount
Salary - By Title and salary range: Town Administrator $65-$70/hr Health Agent $30-$35/hr Conservation Volunteers $29/hr			**$16,785**	**$ 19,185[1+2]**	**$ 19,185**
Subcontractual Services:					
Engineering Services	$ 12,000	$ 24,000	$ 8,000	$ 8,000[3]	$ 32,000
Phosphorous Inactivation Treatment	$ 87,000	$174,000	$ 41,215	$149,570[4+5]	$323,570
Alum Treatment Pump and Facility		$127,500			$127,500
Feasibility and Design Memorandum for Automated Water Controls				$ 72,450[6+7]	$ 72,450
Automated Water Controls Install				$ 35,000[8]	$ 35,000
Permitting and Permit Requirements					
Grant Management	$ 6,000	$ 6,000	$ 4,000	$ 4,000[9]	$ 10,000
Subtotal:	**$105,000**	**$331,500**	**$53,215**	**$269,020**	**$600,520**
Other:					
Travel:					
Totals:	**$105,000 60%**	**$331,500 53%**	**$70,000 40%**	**$288,205 47%**	**$619,705 100%**

AMENDMENT 2

Project Budget – Amended April 10, 2018

West Monponsett Pond Nutrient Management Project
17-05/319

Expense Items	s.319 Amount	Amendment	Non-Federal Match	Total Amount
Salary - By Title and salary range: Town Administrator $65-$70/hr Health Agent $30-$35/hr Conservation Volunteers $29/hr			**$ 19,185[1+2]**	**$ 19,185**
Subcontractual Services:				
Engineering Services	$ 24,000	$ 24,000	$ 8,000[3]	$ 32,000
Phosphorous Inactivation Treatment	$174,000	$301,500	$149,570[4+5]	$451,070
~~Alum Treatment Pump and Facility~~	$127,500			
Feasibility and Design Memorandum for Automated Water Controls			$ 72,450[6+7]	$ 72,450
Automated Water Controls Install			$ 35,000[8]	$ 35,000
Permitting and Permit Requirements				
Grant Management	$ 6,000	$ 6,000	$ 4,000[9]	$ 10,000
Subtotal:	**$331,500**	**$331,500**	**$269,020**	**$600,520**
Other:				
Travel:				
Totals:	**$331,500 53%**	**$331,500 53%**	**$288,205 47%**	**$619,705 100%**

AMENDMENT 3

Project Budget – Amended May 21, 2019

West Monponsett Pond Nutrient Management Project
17-05/319

Expense Items	s.319 Amount	Amendment	Non-Federal Match	Total Amount
Salary - By Title and salary range: Town Administrator $65-$70/hr Health Agent $30-$35/hr Conservation Volunteers $29/hr			**$ 19,185[1+2]**	**$ 19,185**
Subcontractual Services:				
Engineering Services	$ 24,000	$ 24,000	$ 8,000[3]	$ 32,000
Phosphorous Inactivation Treatment	$174,000	$301,500	$149,570[4+5]	$451,070
~~Alum Treatment Pump and Facility~~	$127,500			
Feasibility and Design Memorandum for Automated Water Controls			$ 72,450[6+7]	$ 72,450
Automated Water Controls Install			$ 35,000[8]	$ 35,000
Permitting and Permit Requirements Grant Management	$ 6,000	$ 6,000	$ 4,000[9]	$ 10,000
Subtotal:	**$331,500**	**$331,500**	**$269,020**	**$600,520**
Other:				
Travel:				
Totals:	**$331,500 53%**	**$331,500 53%**	**$288,205 47%**	**$619,705 100%**

FINAL PROJECT COST: $581,844.00

FUNDING:	US EPA / s.319 Program:	$331,500.00
	Town of Halifax:	$250,344.00

Task 1. Quality Assurance and Project Evaluation. This was covered under the FFY 2015-2020 Departments Program 319 Program Quality Assurance Project Plan. No project funds were expended to this task.

Task 2. Permitting. The Town of Halifax had an Order of Conditions already in place lasting through 2019. In addition, the Town received all approvals from Natural Heritage and Endangered Species. These are included as attachments to this report. No project funds were expended to this task.

Task 3. First Phase Buffered Alum Treatment. This was previously completed in 2015 and proposed as a project match.

Task 4. Second Phase Buffered Alum Treatment. This was previously completed in 2016 and proposed as a project match.

Task 5. Third Phase Buffered Alum Treatment. This was completed in 2017 by Solitude Lake Management for a fee of $207,150 as requested in DEP invoice numbers 2 and 3 as part of this project. Summary report is included as an attachment.

Task 5B. Fourth Phase Buffered Alum Treatment. This was completed in 2018 by Solitude Lake Management for a fee of $100,731 as requested in DEP invoice numbers 6 and 9 as part of this project. Summary report is included as an attachment.

Task 5C. Fifth Phase Buffered Alum Treatment. This was completed in 2019 by Solitude Lake Management for a fee of $78,733 as requested in DEP invoice number 10 as part of this project. Summary is included as an attachment.

Task 6. SCADA Feasibility and Design Memorandum at the Monponsett Pond System. This was completed in 2015 and proposed as project match.

Task 7. Installation of Water Control Valves. This was completed in 2015 and proposed as project match.

Task 8. Design and Installation of an Alum Treatment Facility. This was struck per the final contract amendment.

Task 9. Outreach and Education. This was completed by the Town of Halifax. Summaries are included as an attachment to this report.

Task 10. Reporting and Project Oversight. This was completed by GHD for the fee of $30,000. A total of 9 quarterly reports have been developed and submitted. They are not attached to this report, but may be provided upon request.

In total, consulting fees between Solitude Lake Management and GHD totaled $416,614.00.

The scope of work included several previously completed items to serve as a cash match (Tasks 3, 4, 6, and 7).

The Town of Halifax provided a match of $250,344, resulting in a 43% match. This match is comprised of cash, previous alum treatments, a cash contribution from the Massachusetts Department of Public Health to assist with payment for the 2018 alum treatment, Town funds and a past SWMI grant.

DURATION: January 2017 – June 2019

OBJECTIVES:

The goal of this project is to reduce the concentration of blue green algae that are capable of producing dangerous toxins that are linked to serious health effects including skin rashes, gastric distress and respiratory problems by using a methodology, or treatment, protects the habitat of the state-listed species of special concern. The project goals align with the previous grants that have been awarded to the Town of Halifax that include multiple Sustainable Water Management Initiative (SWMI) grants in 2013 and 2015, EPA WMOST modeling in 2014, Division of Ecologic Restoration Priority Project Status in 2014 and most recently an award from the New

England Interstate Water Pollution Control Commission. All of these grants have focused on improving the health of this waterbody

METHODS EMPLOYED/PROJECT TASKS:

2017. Over a nine day period during the 2017 season, alum applications were administered throughout 7 days, June 6th through June 14th, excluding the weekend. The applications were conducted with a specially equipped treatment vessel (Image 1). The treatment vessel was equipped with two translucent polyethylene tanks, in addition to a fathometer, speedometer, in-line pressure gauges and flowmeters to measure and ensure appropriate chemical delivery. Two separate pumping systems were used to apply aluminum sulfate and sodium aluminate to areas greater than 4' in depth in the West Basin of Monponsett Pond, an area totaling 232 acres. The 232-acre treatment area was divided into three predetermined treatment zones (Image 2) with similar depth characteristics in order to ensure accurate dosing and a more uniform application of the alum and sodium aluminate. An areal dose of 17 g/m2 was applied to each treatment area. Over the course of the seven-day treatment, a total of 33,162 gallons of aluminum sulfate and 16,762 gallons of sodium aluminate were applied to West Monponsett Pond. A map of the treatment vessel tracks from the entire treatment event is provided in Image 3.

Image 1: Treatment Vessel

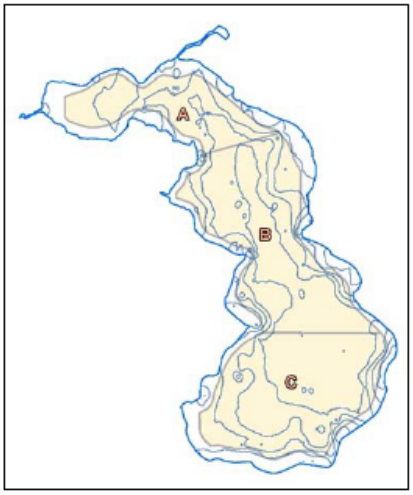


Image 2: Treatment Zones of the Western Basin of Monponsett Pond

Image 3: 2017 Alum Treatment tracks

2018. The tasks performed as part of the 2018 treatment program are outlined below.

- Received approved MA DEP License to Apply Chemicals: 5/14/2018
- Alum treatment: 5/15/2018 – 5/18/2018

Alum applications were administered throughout four days: May 15th through May 18th. The applications were conducted with a specially equipped treatment vessel (Image 1). The treatment

vessel was equipped with two translucent polyethylene tanks, in addition to a fathometer, speedometer, in-line pressure gauges and flowmeters to measure and ensure appropriate chemical delivery. Two separate pumping systems were used to apply aluminum sulfate and sodium aluminate to areas greater than 4' in depth in the West Basin of Monponsett Pond, an area totaling 232 acres. The 232-acre treatment area was divided into three pre-determined treatment zones (Image 2) with similar depth characteristics in order to ensure accurate dosing and a more uniform application of the alum and sodium aluminate. An areal dose of 10 g/m^2 was applied to each treatment area. Over the course of the four-day treatment, a total of 19,000 gallons of aluminum sulfate and 9,500 gallons of sodium aluminate were applied to West Monponsett Pond. A map of the treatment vessel tracks from the entire treatment event is provided in Image 3.

2019. The tasks performed as part of the 2019 treatment program are outlined below.

- Preparation of alum treatment: 06/17/2019 – 06/21/2019
- Equipment mobilization: 06/24/2019
- Alum treatment: 06/25/2019 – 06/27/2019
- Equipment demobilization: 06/28/2019

RESULTS:

Please refer to Section V of the attached 2017 and 2018 Year End Alum Treatment Reports in the Task 5 (2017) and 5b (2018) deliverables provided by Solitude Lake Management.

D. Best Management Practices

Type of BMP: Phosphorus Inactivation Treatment of West Monponsett Pond

Date of implementation: 2017: June 6 through June 14
2018: May 11 through May 21
2019: June 25 through June 27

Size of treatment area: 232 acres

Area land use: Developed areas on south, east and north shorelines, agricultural (cranberry bogs) on the west shoreline.

Pollutant load removed: 614.8 lbs sequestered, 305 lbs in-lake reduction

Method of pollutant load removal determination and calculations:

The water quality monitoring was comprised of sample collection for laboratory analysis and basic in-situ testing. Water quality samples were collected at predetermined locations within each treatment area immediately before and after the June treatment event, as well as, once a month for four months after the treatment. Each sample was analyzed for: water clarity, pH, turbidity, alkalinity, total phosphorus, and dissolved phosphorus (Appendix B, Table 1 of the 2017 ad 2018 Year End Alum Treatment Reports). The in-situ treatment testing was performed at the same

predetermined locations before, during and after each treatment day. The testing included temp/dissolved oxygen, water clarity, pH, and alkalinity (Appendix B, Table 2 of the 2017 ad 2018 Year End Alum Treatment Reports).

In laboratory results, 1 pound of aluminum will bind with one pound of phosphorus. In an aquatic environment, the ratio is closer to 10:1. Therefor by calculating the pounds of aluminum sulfate applied and divided by 10 will yield the amount of phosphorus sequestered. This ratio has been determined by industry professionals as the suggested threshold for extended alum treatments as in the case of West Monponsett Pond.

For the in-lake reduction, MassDEP provided guidance on the pond volume and pre and post treatment concentrations which were used to develop the total phosphorus in-lake reduction.

Signed statement:

The estimations in this report were determined using the appropriate estimation model and applied according to the procedures prescribed for the model. To the best of my knowledge these are reasonable estimates using appropriate methods. Documentation is kept on file by the grantee and is available for review by MassDEP/EPA.

Cathleen Drinan
Health Agent
Town of Halifax

E. Lessons Learned

This project included contract and grant amendments. Organized record keeping was therefore critical for project success. The process of the alum dosing is relatively common and was completed without any unanticipated complications for this specific project. However, with any work on waterbodies, it is critical to make sure all permits are in place and the public is aware of the project. Previous approvals provided by an on-going Order of Conditions and coordination with NHESP prior to the alum treatments paved the way for a straight forward implementation. During the treatments, the boat ramp of West Monponsett was reserved for the project and public notifications allowed this to occur with little interference.

The project was amended from the original scope of work to include a task item for an alum pump facility (design, permitting and construction) with a budgeted fee of $127,500. A request for proposals for the alum pump house was distributed by the Town of Halifax, however fees submitted by proposers exceeded the allocated funds. Because of this, the alum pump house was removed from the project as part of Amendment 2.

The original project budget, amendment 1, amendment 2, and amendment 3 have been included in this report.

F. Attachments / Deliverables:

TASK 1, 5, 5b, 5c – Attached, all requested information is included in the 2017 and 2018 Solitude Year End Alum Treatment Reports.

TASK 2 – Attached, approved Order of Conditions

TASK 3, 4, and 6 – Completed, deliverables previously submitted to Massachusetts Department of Environmental Protection, not included in this report.

TASK 7 – To be completed by City of Brockton, not included in this report.

TASK 8 – Struck per amendment dated April 10, 2018

TASK 9 – Attached, Outreach and Education

Deliverables:
Task 1, 5a and 5b. 2017 and 2018 Year End Alum Reports (Including Documentation of BMP Implementation Work)

West Monponsett Pond

Halifax and Hanson, Massachusetts

2017 Year-End Alum Treatment Report

Prepared for:
Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Prepared by:
SŌLitude Lake Management
590 Lake Street
Shrewsbury, MA 01545

Table of Contents

Appendices

Appendix A
'REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond' (SŌLitude Lake Management, 2017)

Appendix B
Treatment Monitoring Program at the West Basin of Monponsett Pond Raw Data (Table 1-4)

Appendix C
Mussel and Dragonfly Monitoring Report by Biodrawversity LLC, "*Effects of an Alum Treatment on Freshwater Mussels and Dragonflies in West Monponsett Pond: 2017 Monitoring*"

I. INTRODUCTION

Monponsett Pond located in the towns of Halifax and Hanson, Massachusetts, is a significant ecological, historical, and recreational resource as well as an important supplementary water supply for the nearby City of Brockton. The 528-acre pond is bisected by Route 58, which splits the water body into two basins - East and West - directly connected by a small culvert in the Southern portion of the pond. Both basins are highly developed with residential homes and receive inputs from a suburban watershed of approximately six square miles.

As a whole, Monponsett Pond has been heavily impacted by the use of its waters and watershed, and both basins have been listed as Category 5 "Impaired" waterbodies on the Massachusetts Integrated List of Waters (303(d) list). The East Basin was listed for nuisance aquatic plants and mercury in fish. A TMDL was approved by the EPA for mercury, thus removing the basin from the list of impaired waters. The Western basin appears on the 2014 303(d) list as a category 5 water body for nutrients, noxious aquatic plants, transparency, and exotic species. The West Basin was included in the mercury TMDL and a draft TMDL for phosphorus was released in November of 2016.

Both basins, especially the West Basin, have been subject to extensive nuisance algae blooms (specifically cyanobacteria – blue-green algae) for many years. During recent summers, these blooms prompted the frequent closure of the Western basin to swimming and boating. Algae testing has been carried out both by the Massachusetts Department of Public Health (MA DPH) and Massachusetts Department of Environmental Protection (MA DEP) throughout the summer months. MA DPH also conducted analysis of water quality, including total phosphorus. These results show a definite correlation between concentration of total phosphorus and total algal cell count in the Western basin throughout the summer. Previous testing and the TMDL have determined that internal loading of phosphorus is prominent in the West Basin, along with watershed loading.

Despite these water quality challenges, the Western basin has been identified as an area of priority habitat by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Program (NHESP). Three state-listed species of special concern have been confirmed in West Monponsett Pond: Tidewater Mucket (*Leptodea ochracea*), Eastern Pondmussel (*Ligumia nasuta*), and Umber Shadowdragon (*Neurocordulia obsoleta*).

Internal Phosphorus Management

Understanding the correlation between phosphorus levels and growth of potentially harmful cyanobacteria, the Town of Halifax, in cooperation with MA DEP, has investigated and implemented phosphorus management activities in West Monponsett Pond**.**

Various parties have been addressing watershed phosphorus loading including efforts by nearby cranberry bogs. Work focusing on internal phosphorous inactivation began in 2013, under Lycott Environmental, in accordance with the NHESP letter (09-27490) dated June 6, 2012, and the submitted Habitat Management Plan. In that year, a volumetric dose of 3.0 ppm Al was applied in one treatment for a total areal (sediment) dose of 7.1 g/m2. No treatment occurred in 2014, and in 2015 the dose and method were changed to a total of 2.1 ppm Al over three treatments (0.7 ppm each), resulting in an additional sediment dose of 4.9 g/m2 Al. The 2016 season saw one application of 1.4 ppm Al, depositing 3.2 g/m2 Al on the pond bottom. Prior to 2017, a total of 15.2 g/m2 of aluminum have been applied to the bottom of the Western basin.

Based on experience in similar lakes and the assessment of sediment phosphorus release, a sediment dose of up to 50 g/m^2 is likely to be needed in order to sufficiently reduce internal phosphorus recycling. The ongoing sediment release, in addition to annual watershed loading, has resulted in reduced efficacy of the current treatment plan on controlling nuisance bloom conditions.

Following award of a 319 Grant to the Town of Halifax and revision of the Habitat Management Plan with NHESP in 2017, the current plan involved an early season application of 17.0 g/m2 (~8 ppm Al). The plan aimed to inactivate a sufficient amount of available phosphorous in the pond sediment to provide desirably low growth of cyanobacteria. Past treatments have sequentially reduced phosphorus levels in the West Basin and it was estimated that the proposed treatment will meet WQ goals, at least for a period of time.

II. PERMITTING

U.S. Environmental Protection Agency National Pollution Discharge Elimination System Permit

Lycott Environmental filed an electronic Notice of Intent (eNOI) under the U.S. Environmental Protection Agency Pesticide General Permit (PGP) for the application of pesticides to the Monponsett Ponds on behalf of the Town of Halifax on May 9, 2012. This application was signed and submitted by the Town of Halifax on May 19, 2013, which then received an active status ten days following its submission. The NOI remains valid until May of 2018.

Massachusetts Endangered Species Act Project Review

A 'REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond' was submitted to the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Review Program (NHESP) on March 27, 2017. The NHESP provided approval correspondence on May 4, 2017.

Order of Conditions

The Orders of Conditions (Halifax & Hanson) have been automatically extended by the Permit Extension Act and are therefore valid for an additional four years from the original date of expiration or until 2019. Revised alum treatment plans were presented to both Commissions in the spring of 2017.

Image 1: Treatment Vessel

Massachusetts Department of Environmental Protection License to Apply Chemicals

SLM prepared and filed for the required License to Apply Chemicals permit from MA DEP Office of Watershed Management; the approved license was issued on June 2, 2017 (#17266).

III. 2017 TREATMENT PROGRAM CHRONOLOGY

The tasks performed as part of the 2017 treatment program are outlined below.

- Received approved MA DEP License to Apply Chemicals — 6/05/2017
- Received management plan approval from NHESP — 5/04/2017
- Alum treatment — 6/06 - 6/14/2017

IV. TREATMENT LOGISTICS

Over a nine (9) day period during the 2017 season, alum applications were administered throughout seven (7) days: June 6th through June 14th, excluding the weekend. The applications were conducted with a specially equipped treatment vessel (**Image 1**). The treatment vessel was equipped with 2 translucent polyethylene tanks,

in addition to a fathometer, speedometer, in-line pressure gauges and flowmeters to measure and ensure appropriate chemical delivery. Two separate pumping systems were used to apply aluminum sulfate and sodium aluminate to areas greater than 4' in depth in the West Basin of Monponsett Pond, an area totaling 235 acres. The 235-acre treatment area was divided into three pre-determined treatment zones (**Image 2**) with similar depth characteristics in order to ensure accurate dosing and a more uniform application of the alum and sodium aluminate. An areal dose of 17 g/m^2 was applied to each treatment area. Over the course of the seven-day treatment, a total of 33,162 gallons of aluminum sulfate and 16,762 gallons of sodium aluminate were applied to West Monponsett Pond. A map of the treatment vessel tracks from the entire treatment event is provided in **Image 3**.

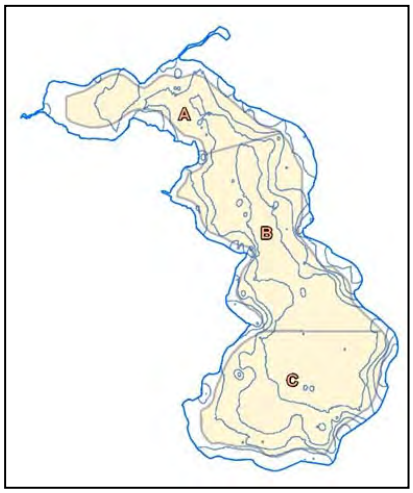


Image 2: Treatment Zones of the Western Basin of Monponsett Pond

Image 3: 2017 Alum Treatment tracks

V. MONITORING PROGRAM

The following table outlines the major components of the monitoring program and their respective goals, as approved in the habitat management plan ('**Appendix A**').

Table 1. Monitoring program design

Monitoring component	Timing in relation to treatment	Location(s)	Goals
Water Quality	Before, during and after application	Established location within each treatment zone	Evaluate short and long-term effects on water quality
	Monthly		Monitor summer long water quality and algae conditions
Monitoring of state-listed species	Upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cell/ml), one year following completion of alum treatments and 5-years after completion of alum treatments	5 paired plots	Evaluate short and long-term effects on these species identified by NHESP as potentially susceptible to the treatment

a. WATER QUALITY MONITORING

The water quality monitoring was comprised of sample collection for laboratory analysis and basic *in-situ* testing. Water quality samples were collected at predetermined locations within each treatment area immediately before and after the June treatment event, as well as, once a month for four months after the treatment. Each sample was analyzed for: water clarity, pH, turbidity, alkalinity, total phosphorus, and dissolved phosphorus ('**Appendix B, Table 1**'). The *in-situ* treatment testing was performed at the same predetermined locations before, during and after each treatment day. The testing included temp/dissolved oxygen, water clarity, pH, and alkalinity ('**Appendix B, Table 2**').

Total Phosphorus Monitoring

A total phosphorus measurement was collected before and after the June treatment event, and subsequently once a month until October (**Figure 1**). Total phosphorus levels decreased overall following the treatment event, but spiked in August before decreasing again in September and October. The results show a reduction in total phosphorus of roughly 50% (Avg. 28 ppb June – Avg. 12 ppb October) during the course of the season.

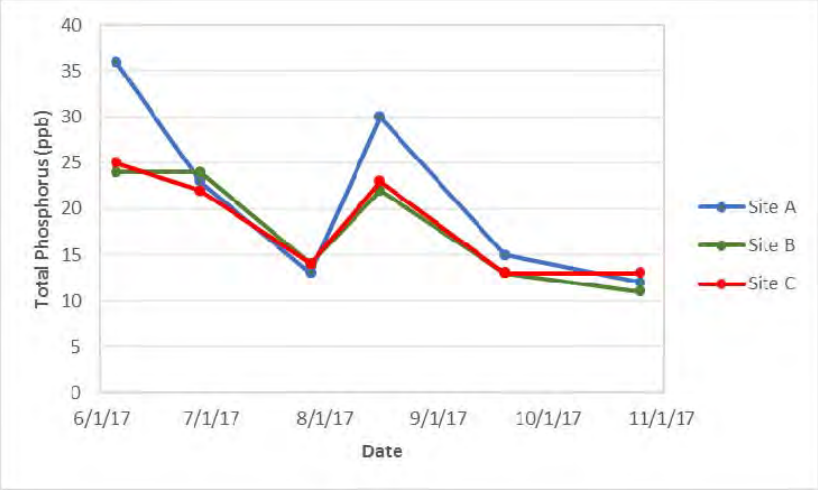


Figure 1: Comparison of total phosphorus (ppb) from June to October.

Dissolved Phosphorus Monitoring

A dissolved phosphorus measurement was collected before and after the June treatment event, and subsequently once a month until October (**Figure 2**). Dissolved phosphorus levels remained steady over the first month after the treatment event, with a slight increase. However, in the following months the dissolved phosphorus began to steadily drop until it reached levels that were too low to be detected by instruments, at less than 10 ppb (indicated by values at 10 ppb). Overall, the results show a significant reduction in dissolved phosphorus during the course of the season.

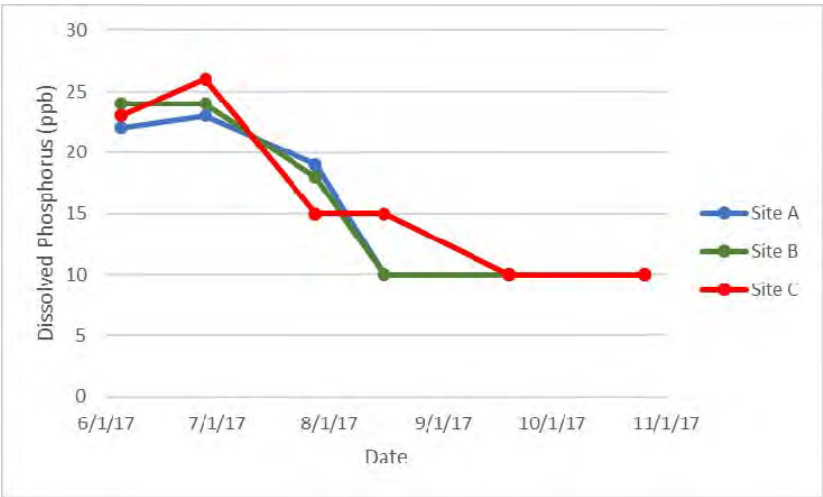


Figure 2: Comparison of dissolved phosphorus (ppb) from June to October.

Dissolved Oxygen Monitoring

A dissolved oxygen measurement was collected once a month from June to October (**Figure 3**). A slight increase in dissolved oxygen was observed following the June treatment event; however, levels later decreased, before increasing again at the final measurement. The dissolved oxygen measurements revealed that levels remained within a suitable range (> 5 mg/L) for wildlife populations throughout the duration of the program and were not substantially impacted by the buffered alum treatments.

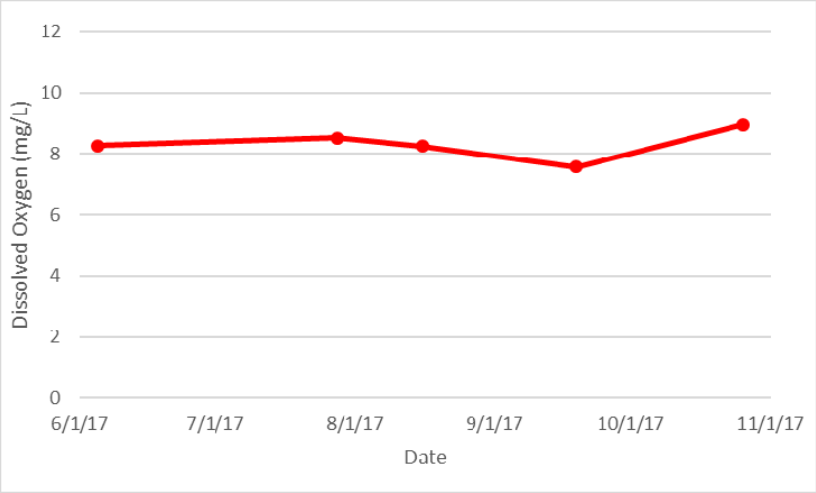


Figure 3: Average dissolved oxygen (mg/L) sampling results of all three treatment zones from June to October.

Water Clarity Monitoring (via Secchi Disk)

Water clarity was measured before, during and after each day of the June treatment event, and subsequently once per month until October (**Figure 4**). Throughout the seven days of the treatment event, the Secchi depth increased steadily, until July when it began to decrease. The depth continued to decrease until October, when it began to return to depths seen during the treatment event. The reduction in water clarity (Secchi depth) after June correlates with an increase in algal cell density.

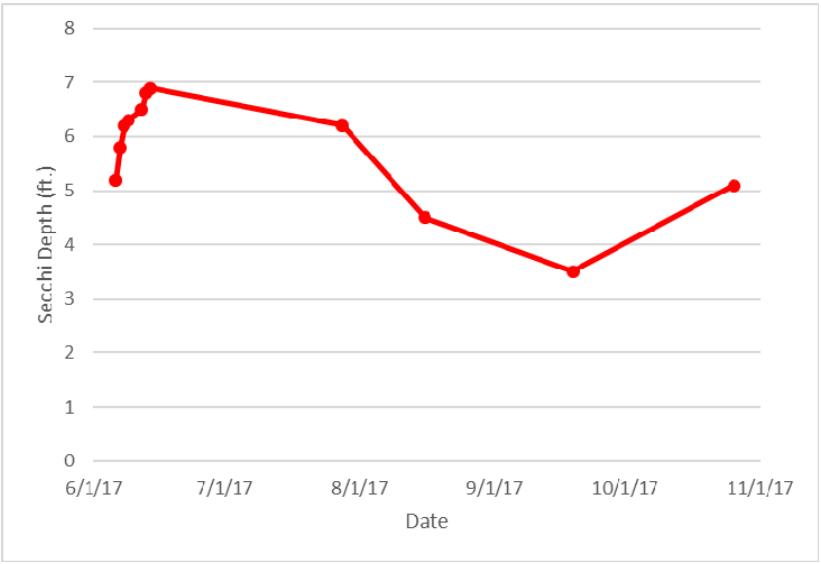


Figure 4: Average Secchi Disk depth (ft.) results of all three treatment zones throughout June treatment event and the following four months.

pH Monitoring

A pH measurement was collected before, during and after each day of the June treatment event (**Figure 5**). Overall, the results show relatively constant pH levels between 6 and 7 SU, with minimal fluctuation throughout the treatment event.

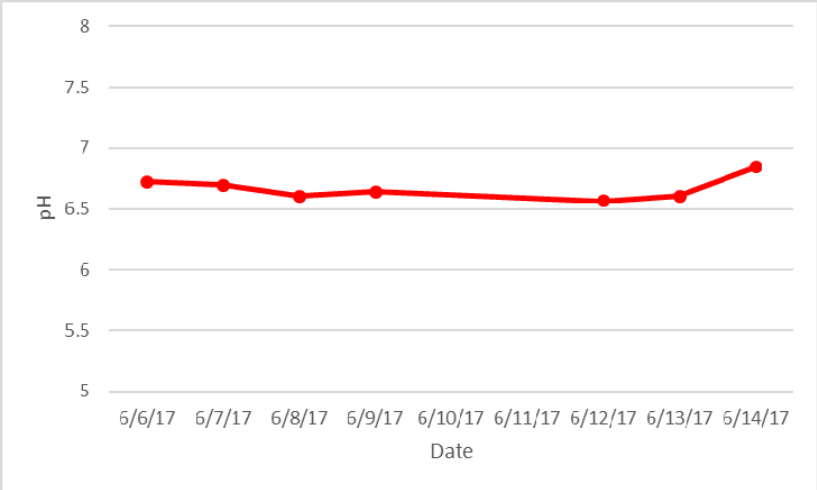


Figure 5: Average pH results of all three treatment zones throughout June treatment event.

Total Alkalinity Monitoring

Total alkalinity was measured before, during and after each day of the June treatment event, and subsequently once per month until October (**Figure 6**). The total alkalinity measurements remained between approximately 8 and 14 mg/L throughout the treatment event, with some fluctuation between each day. In the following months the total alkalinity steadily increased, before plateauing.

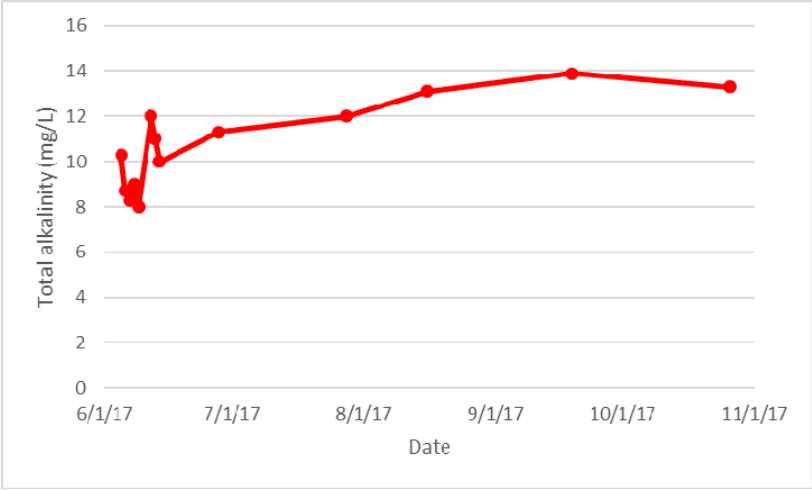


Figure 6: Average total alkalinity (mg/L) results of all three treatment zones throughout June treatment event and the following four months.

b. ALGAE SAMPLING

A single monthly sample (June-October) was collected from Area B within the West Basin for algae species identification and characterization of general species abundance/dominance. Based on the results of these samples the algae assemblage presented a fair amount of variance from month to month. See **Table 1** for a breakdown of the natural count/mL of each phylum of algae observed in the monthly samples.

Table 1:	Phylum of Algae (Natural Unit Count/mL)				
Date	**Diatomaceae**	**Rotifera**	**Chlorophyceae**	**Cyanophyceae**	**Protozoa**
6/5/17	314	30	135	12	64
6/28/17	106	-	53	597	14
7/28/17	-	-	202	220	190
8/16/17	144	-	19	73	-
9/19/17	139	-	87	129	139
10/26/17	12	-	110	118	144

The most abundant and frequently observed blue-green algae were *Anabaena* and *Psuedanabaena*. The unicellular, colonial blue-green *Microcystis* was prevalent in the October sample. Other common genus' were comprised of primarily diatoms (*Cyclotella* and *Synedra*) and green algae (*Ankistrodesmus*, *Closterium, Coelastrum*, and *Ulothrix*). The blue-green algae cell count fluctuated throughout the 2017 management season, with the lowest abundance occurring at the start of June and the greatest in the middle of September (**Figure 7**).

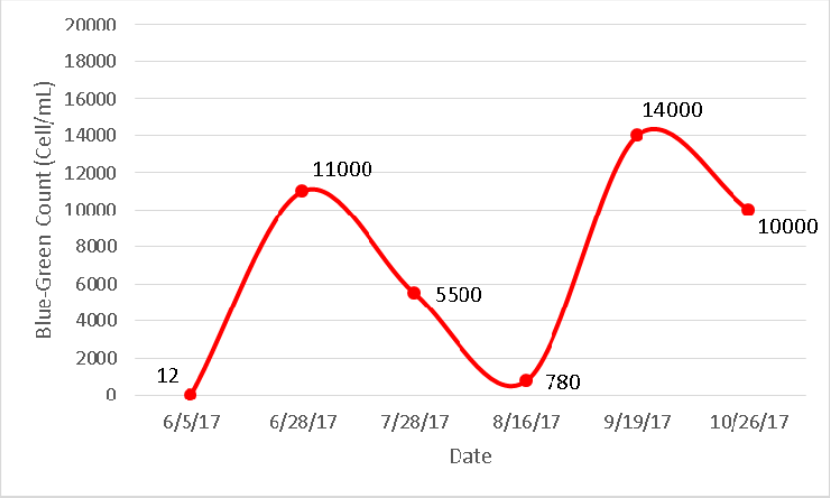


Figure 7: Blue-Green Cell Count/mL from June to October.

c. MUSSEL AND DRAGONFLY MONITORING

As a part of the Habitat Management Plan, an ongoing program initiated in 2013 to monitor mussel and dragonfly populations in West Monponsett was continued in 2017. Biodrawversity LLC was hired to complete

the monitoring, providing their methodology and findings in the report titled "*Effects of an Alum Treatment on Freshwater Mussels and Dragonflies in West Monponsett Pond: 2017 Monitoring*" (**'Appendix C'**). During the 2017 post-treatment monitoring, five mussel species were present with a total of 2,536 individual mussels observed. *Elliptio complanata* was the dominant species at 76.5% of all observed mussels, with *Leptodea ochracea* the second most abundant at 14.3%. The state-listed species of special concern, *Leptodea ochracea* and *Ligumia nasuta*, had 363 and 46 individuals observed in 2017, respectively. Overall, the density of mussels was higher in 2017 in comparison to 2013 and 2014.

Throughout the monitoring program, thirteen dragonfly species have been found in West Monponsett pond. The state-listed species *Neurocordulia obsoleta* was observed in two locations in 2017, specifically within or close to the culvert between West and East Monponsett Pond. The study ultimately concluded, "data do not indicate that the alum treatment had any adverse effect on juveniles or adults of any mussel species". Additionally, the study found no apparent difference in the presence of listed dragonfly species as compared to the pre-treatment baseline in 2011. Listed species were present following the alum treatments in 2013 & 2017.

VI. DISCUSSION/CONCLUSION

Overall, the 2017 alum treatment at West Monponsett Pond was conducted successfully and with no adverse effects on water quality or non-target organisms. The treatment served to apply an additional 17 g/m^2 of aluminum to the sediment in order to further counteract internal phosphorus loading. Monthly water quality sampling showed overall improvements in phosphorus concentrations, water clarity and algae populations as compared to previous years.

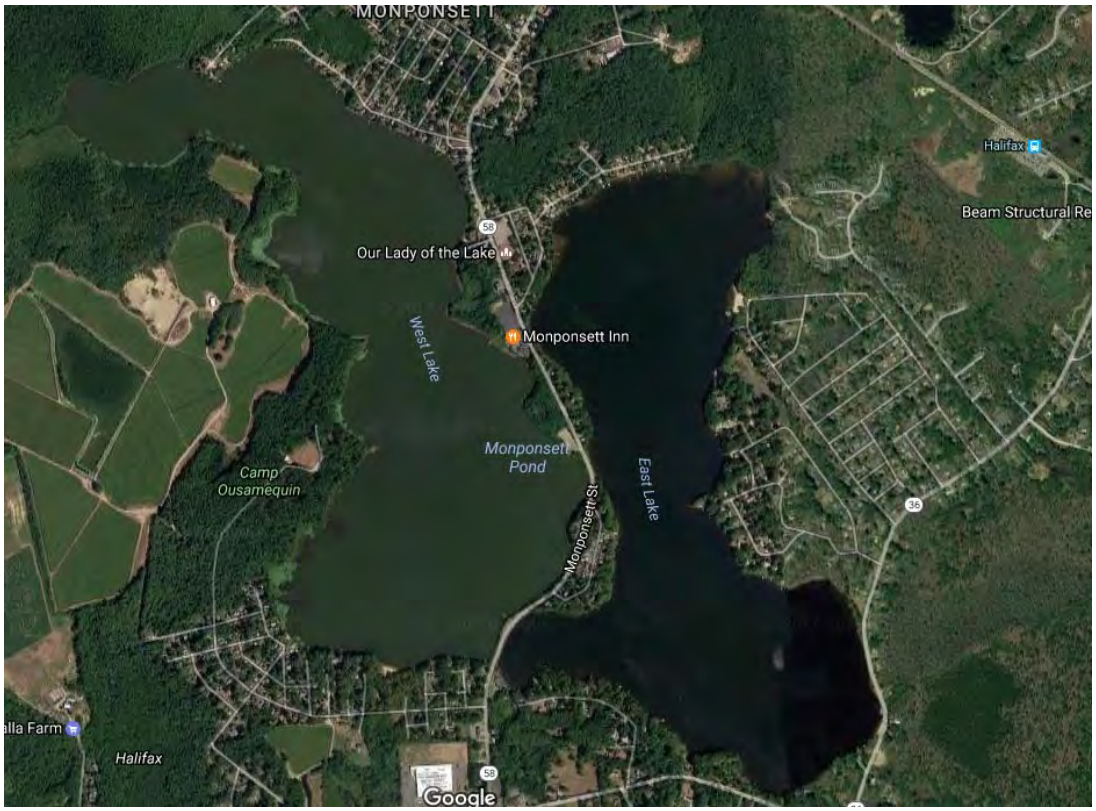
Unfortunately, based on MassDEP algae sampling of near shore areas, algae density did exceed the MA DPH threshold of 70,000 cells/ml at many points and the pond was closed to recreation for much of the summer. This was a wet year and watershed loading to the system was likely high, which may have counteracted the improvements made with the alum treatment. Regardless, the condition of the pond was much improved this year and the algae counts were much lower than seen in previous years. Hopefully, the pond will continue to improve in 2018 as a result of this treatment, especially if precipitation levels are more normal.

We understand that the Town is pursuing the design of an alum dosing system that can be used on an as needed basis to treat periodic watershed loading and continue to contribute to the inactivation of available sediment phosphorus. We are willing to contribute to any planning activities the Town may be conducting and discuss any additional in-lake treatments as necessary.

Appendix A

REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond

REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond (2017)



Applicant: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Representative: SOLitude Lake Management
590 Lake Street
Shrewsbury, MA 01545

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REVISED Habitat Management Plan for Phosphorus Inactivation in the West Basin of Monponsett Pond Halifax/Hanson, Massachusetts 2017

SITE DESCRIPTION & BACKGROUND

Monponsett Pond, located in the towns of Halifax and Hanson, Massachusetts, is a significant ecological, historical, and recreational resource as well as an important supplementary water supply for the nearby City of Brockton. The 528-acre pond is bisected by Route 58, which splits the water body into two basins - East and West - directly connected by a small culvert in the Southern portion of the pond. Both basins are highly developed with residential homes, and receive inputs from a suburban watershed of approximately 6 mi^2.

As a whole, Monponsett Pond has been heavily impacted by the use of its waters and watershed, and both basins have been placed on the Massachusetts Integrated List of Waters (303(d) list). Since 2010, the Eastern basin has been categorized as a 4c water body for presence of exotic species and a Total Maximum Daily Load (TMDL) was published in 2007 for high concentrations of mercury. The Western basin appears on the 2010 303(d) list as a category 5 water body for nutrients, noxious aquatic plants, turbidity, and exotic species. A draft TMDL for phosphorus was released in November of 2016. The presence of two exotic aquatic vegetation species; Fanwort (*Cabomba caroliniana*) and Variable Milfoil (*Myriophyllum heterophyllum*), have been recorded in the Eastern basin, while presence of Fanwort was noted in the Western basin.

Both basins have also been subject to extensive nuisance algae blooms (specifically cyanobacteria – blue-green algae) for many years. During recent summers, these blooms prompted the frequent closure of the Western basin to swimming and boating. Algae testing has been carried out both by the Massachusetts Department of Public Health (MA DPH) and Massachusetts Department of Environmental Protection (MA DEP) throughout the summer months. MA DPH also conducted analysis of water quality, including total phosphorus. These results show a definite correlation between concentration of total phosphorus and total cell count in the Western basin throughout the summer.

Despite these water quality challenges, the Western basin has been identified as an area of priority habitat by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Program (NHESP). Three state-listed species of special concern has been confirmed in West Monponsett Pond: Tidewater Mucket (*Leptodea ochracea*), Eastern Pondmussel (*Ligumia nasuta*), and Umber Shadowdragon (*Neurocordulia obsoleta*).

PROPOSED PHOSPHORUS INACTIVATION PROGRAM

This phosphorous inactivation project began in 2013, under Lycott Environmental, in accordance with the NHESP letter (09-27490) dated June 6, 2012, and the submitted Habitat Management Plan. In that year, a volumetric dose of 3.0 ppm Al was applied in one treatment for a total areal (sediment) dose of 7.1 g/m^2. No treatment occurred in 2014, and in 2015 the dose and method was changed to a total of 2.1 ppm Al over three treatments (0.7 ppm each), resulting in an additional sediment dose of 4.9 g/m^2 Al. The 2016 season saw one application of 1.4 ppm Al, depositing 3.2 g/m^2 Al on the pond bottom. To date a total of 15.2 g/m^2 of aluminum has been applied onto the pond bottom.

Table 1-Historical Dosing Information

Treatment Year	Volumetric Dose	Areal Dose	Notes
2013	3.0 ppm	7.1 g/m^2	Single application
2015	2.1 ppm	4.9 g/m^2	Split over three applications
2013	1.4 ppm	3.2 g/m^2	Single application
Total Areal Dose Applied		**15.2 g/m^2**	

Based on experience in other similar lakes and assessments of the sediment phosphorus release, a sediment dose of up to 50 g/m^2 is likely to be needed in order to sufficiently reduce internal phosphorus recycling. This ongoing sediment release in addition to annual watershed loading has resulted in reduced efficacy of the current treatment plan on controlling nuisance bloom conditions. Based on recent discussion with Mark Mattson (MassDEP) modifications to the management plan are proposed. As a note, based on the recent phosphorus TMDL draft, alum treatment may be conducted in the East Basin of Monponsett Pond at a reduced dose, however no listed species have been identified in that basin.

Aluminum Dose Modification

In 2017, the alum treatment plan will involve at least one large scale, early season application of 9.0 g/m^2 (~4 ppm Al) with the hope of inactivating a sufficient amount of available phosphorous in the pond sediments to provide desirably low growth of cyanobacteria. Past treatments have sequentially reduced phosphorus levels in the West Basin and it is estimated that the proposed treatment will meet WQ goals at least for a period of time. Depending on available resources, the dose may be increased up to 17.0 g/m^2 as a single or split-application treatment in 2017. Depending on how dramatically conditions improve in the lake, subsequent applications may not be necessary, however the remaining dose (up to the projected total dose of 50 g/m^2) may be applied in 2018 or plans and grants are also being pursued for an alum micro-floc injection system. The benefit of the injection system is that it will be in place to provide an option for addressing continued watershed phosphorus loading on an on-going basis. A summary of the 2017 treatment results and monitoring data will be supplied to NHESP in the fall, to facilitate their review of any proposed treatments in 2018.

Table 2-Proposed Alum Treatments for West Monponsett Pond

Treatment Year	Areal Dose	Notes
2017	9.0-17 g/m^2	Single or split application – any increase above 9 g/m^2 is pending funding and determination of need.
2018	Up to 17 g/m^2	Single or split application – only applied if needed after assessing results of 2017 treatments and pending funding. Also pending review by NHESP.

Treatment Area

No change to the overall extent of the treatment area is proposed. As with the 2013/2015-2016 treatment program, the aluminum sulfate and sodium aluminate will be applied to areas of the West Basin that are deeper than four (4) feet – a total treatment area of approximately 235 acres. We are proposing to divide the overall treatment area into three zones with relatively uniform depth characteristics (Zone A – 45 acres; Zone B – 98 acres; Zone C – 92 acres). This approach will enable accurate dosing and more uniform application without increasing the risk to rare species.

Application Methodology

Treatment will be conducted with our specially equipped treatment vessel. The treatment vessel will be equipped with a fathometer and speedometer. The use of the speedometer enables us to prepare calibration table for chemical delivery (gal/min) versus vessel speed (mph) which will insure even distribution of the alum and sodium aluminate. Suitable in-line pressure gauges and flowmeters to measure chemical delivery rates will also be used.

The treatment vessel will be equipped with 2 translucent polyethylene tanks with a combined capacity of up to 1,500 gallons. These tanks are also graduated on the outside, which allows our operators to visually monitor chemical delivery to insure the desired volumetric ratio is met.

Since the two chemicals cannot be tank-mixed prior to application, there are two separate pumping systems for each product including individual spray lines and drop-hoses. The chemical delivery spray boom will be mounted on the stern of the boat where the drop-hoses will emit the chemicals into the propwash of the outboard motor. Dispersing the chemicals into the propwash promotes flash mixing of the two products and ultimately excellent floc formation. Through our extensive prior alum/aluminate treatment experience, we have found that the use of this arrangement and application methodology provides the best results.

The treatment will be guided with an on-board GPS (CASE EX-Guide 250 guidance system). The guidance systems will show the pond and treatment area and treatment sector boundaries. The system logs the path of the treatment vessel. Each load of chemical will be logged and monitored.

The 9 g/m^2 treatment will entail the application of approximately 17,000 gallons of aluminum sulfate and 8,500 gallons of sodium aluminate. The treatment will require 3-4 days to complete.

MONITORING PROGRAM

The table below outlines the components of the monitoring program and the goals of each. Details are provided in the following sections.

Table 1: Monitoring Program Design

Monitoring Component	Timing in relation to treatment	Location(s)	Goal
Water quality	Before, during, and after each application	3 established locations within each treatment zone	Evaluate short and long-term effects on water quality
Monitoring of state-listed species	Upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cell/ml), one year following completion of alum treatments and 5-years after completion of alum treatments	5 paired plots	Evaluate short and long-term effects on these species identified by NHESP as potentially susceptible to the treatment

Water Quality Monitoring

The water quality monitoring plan for West Monponsett Pond will include sampling at a single location within each of the three treatment zones. Sampling collection will occur immediately prior to each treatment and several days following each treatment. In addition to the sample collection, basic *in situ* testing will be performed throughout each alum application.

Each pre and post-treatment water quality sample will be analyzed for the following parameters.

- pH
- Alkalinity
- Total Phosphorus
- Dissolved Phosphorus

The *in situ* testing that will be performed during treatment will include the following.

- Secchi depth
- Dissolved oxygen
- pH
- Alkalinity

Monitoring of State-Listed Mussel Species

Long-term Mussel Monitoring Program

Since the submission of the original 'Habitat Management Plan' in May 2012, the pre-treatment and one year following the initial 2013 alum treatment long-term mussel monitoring event have been performed. Minor modifications to the proposed long-term mussel monitoring provided in the original 'Habitat Management Plan' were made by the NHESP-approved biologist performing these surveys. Monitoring was also conducted in 2015, but was abbreviated in extent due to poor and potentially toxic conditions. In order to maintain comparability with past mussel monitoring events, the modified survey methodology (below) will be implemented on 3 occasions, 1) upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cells/ml), 2) one year following completion of alum treatments and 3) 5 years after completion of alum treatments. This methodology was provided to the NHESP by Biodrawversity in a report titled, "Monitoring the Effects of Low-Dose Alum Treatment on *Leptodea ochracea*, *L. nasuta*, and *Neurocordulia obsolete* in the Western Basin of Monponsett Pond (Halifax, Massachusetts)" and the relevant excerpt is copied below. Per conversations with the NHESP in 2015, additional revisions to this methodology is indicated below in **bold** text.

> *The basic sampling unit [will be] a 1 x 1 meter ($1m^2$) quadrat bounded by a frame, with two centerlines that [divide] the quadrat into four 0.5 x 0.5 meter sections. The centerlines facilitated more careful searching in the low-visibility environment. Quadrat locations [will be] marked with underwater markers and recorded with GPS to enable the precise area of each to be resurveyed. Five quadrats [will be] established at 10 sites (50 quadrats total); the 10 sites [will be] paired (one shallow, one deep) at five locations in the pond (Figure 1). The quadrats [will be] arranged in a consistent pattern at each site (Figure 2). For each quadrat, biologists [will] first [conduct] a visual and tactile search to count the number of mussels (all species) occurring at or near the surface. The biologists then [will excavate] and [sieve] sediment from within one-fourth ($0.25m^2$) of the quadrat area to find buried mussels. Surface counts and buried counts [will be] recorded for each species, and shell length* ***and shell condition*** *[will be] recorded for L. ochracea and L. nasuta. Once these two steps [are] completed, all mussels [will be] placed back within the confines of the each quadrat. The following habitat information [will be] recorded for each quadrat: water depth, spatial extent of each substrate type, and percent cover of macrophytes. During the two post-treatment surveys, biologists [will] also [count]* ***and note shell condition of*** *freshly dead shells in addition to the steps described above.*

Figure 1 & 2. Mussel and Dragonfly monitoring stations (**Figure 1**) and quadrat arrange (**Figure 2**) derived from Biodrawversity's 2014 report, "Monitoring the Effects of Low-Dose Alum Treatment *Leptodea ochracea*, *Ligumia nasuta*, and *Neurocordulia obsolete* in Monponsett Pond.

Figure 1. Locations of mussel monitoring sites (Sites 1-5, including shallow and deep plots at each site) and dragonfly survey sites (E-1, E-2, and W-1 to W-7) in West and East Monponsett Pond in Halifax, MA.

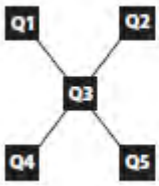

Figure 2. Spatial array of 5 1.0 m² quadrats (Q) at each site. Bricks were left on the lake bottom at Q1, Q2, Q4, and Q5; these were connected by strings and the intersection of the two strings marked the location of Q3. These were easily installed in 2013 and found again in 2014.

Monitoring of State-Listed Dragonfly Species

Long-term Dragonfly Monitoring Program

As stated above, since the submission of the original 'Habitat Management Plan' in May 2012, the pre- treatment and one year following the initial 2013 alum treatment long-term dragon-fly monitoring event have been performed. Minor modifications to the proposed long-term mussel monitoring were made by the NHESP-approved biologist performing these surveys. In order to maintain comparability with past events, the modified survey methodology will be implemented on 3 occasions, 1) upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cells/ml), 2) one year following completion of alum treatments and 3) 5 years after completion of alum treatments.. This methodology was provided to the NHESP in a report titled, "Monitoring the Effects of Low-Dose Alum Treatment on *Leptodea ochracea*, *L. nasuta*, and *Neurocordulia obsolete* in the Western Basin of Monponsett Pond (Halifax, Massachusetts)" and the relevant excerpt is copied below. No additional revisions were requested during previous conversations with the NHESP.

> *Dragonfly surveys, focusing on N. obsoleta … [is scheduled to be completed in 2018]. Survey timing… [will]… accommodate weather conditions during the emergence period to ensure that surveys [are] conducted under the best possible conditions. Qualitative surveys of larvae, exuviae, and tenerals [will be conducted] using a combination of aquatic D-net sweeps in or near aquatic vegetation and other submerged structure,*

snorkeling in shallow water to hand-pick larvae, and walking along the shoreline to look for exuviae and tenerals on the lakeshore (especially rocks, bridge abutments, and trees). The causeway between the West and East basins [will be] surveyed most intensively, but several other locations in West and East Monponsett Pond [will] also [be] assessed and surveyed (Figure 1[see above]). Specimens [will be] collected, preserved in alcohol, and identified under a dissecting microscope.

Monitoring of Fish and Wildlife Response to Treatment

As in previous years, *in situ* in-water and shoreline monitoring will investigate any potential mortality of fish and other wildlife as a consequence of the buffered alum treatment. During the buffered alum treatment, *in situ* in-water and shoreline monitoring for fish and/or other wildlife mortalities will be conducted by the treatment/monitoring team. *In situ* in-water and shoreline monitoring will proceed as follows:

- **Treatment team**

    - Licensed applicator and assistant(s) will actively monitor the immediate treatment area for fish and/or wildlife mortality during application

- **Treatment/Monitoring Team**

    - Inspections of the treatment areas will be conducted in conjunction with *in situ* water testing

    - Twice daily (before and after daily treatment) visual inspection of pond's perimeter for fish and/or wildlife mortality will be performed.

Any deceased fish and/or wildlife encountered during *in situ* in-water monitoring will be documented. Documentation will include: written observations regarding the counts (by species), time observed, and photographs of each specimen. All information pertaining to a fish and/or wildlife kill event will be immediately provided to the Division of Fisheries and Wildlife—Southeast (DFW-SE).

REPORTING

During any year that treatment and/or monitoring is performed, the NHESP will be provided with a year-end report. The report will include documentation of any alum treatments performed (i.e., treatment dates and amounts of products applied) and associated monitoring (i.e., pre, in situ, and post-treatment water quality monitoring, and *in situ* monitoring of fish and wildlife in all years, as well as mussel monitoring. The year-end report will also discuss the treatment program's on-going efficacy any conclusion regarding effects of the treatment program to the state-listed species and their habitat.

Appendix B

Treatment Monitoring Program at the West Basin of Monponsett Pond Raw Data (Table 1-2)

Table 1. Monthly water quality sampling results

Date	Site ID	TP (ppb)	DP (ppb)	TAlk (mg/L)	Turbidity (NTU)	DO (mg/L)	Avg. Secchi (ft.)
6/5/17	A	36	22	10.2	2.4	8.5	5.0
	B	24	24	10.5	1.8	7.8	
	C	25	23	10.3	1.9	8.28	
6/28/17	A	36	22	10.2	2.4	X	X
	B	24	24	10.5	1.8	X	
	C	25	23	10.3	1.9	X	
7/28/17	A	13	19	11.9	1.7	8.46	6.2
	B	14	18	12.1	1.8	8.49	
	C	14	15	12.1	1.7	8.53	
8/16/17	A	30	ND	13.0	2.6	X	4.5
	B	22	ND	13.1	2.0	X	
	C	23	15	13.1	2.5	8.25	
9/19/17	A	15	ND	14.3	2.0	X	3.5
	B	13	ND	14.1	2.6	X	
	C	13	ND	13.4	2.5	7.58	
10/26/17	A	12	ND	12.8	1.2	8.43	5.1
	B	22	ND	12.3	2.0	8.93	
	C	12	ND	12.8	1.2	8.96	

X – No data collected

Table 2. *In-situ* water quality sampling results

Date	Site ID	pH (surface)	Avg. Alk (mg/L)	Avg. Secchi (ft)
6/6/17	A	6.73	8.7	5.2
	B	6.67		
	C	6.76		
6/7/17	A	6.52	8.3	5.8
	B	6.74		
	C	6.83		
6/8/17	A	6.6	9	6.2
	B	6.64		
	C	6.57		
6/9/17	A	6.5	8	6.3
	B	6.65		
	C	6.77		
6/12/17	A	6.51	12	6.5
	B	6.66		
	C	6.52		
6/13/17	A	6.57	11	6.8
	B	6.61		
	C	6.64		
6/14/17	A	6.8	10	6.89
	B	6.84		
	C	6.89		

Appendix C

Mussel and Dragonfly Monitoring Report by Biodrawversity LLC,
"*Effects of an Alum Treatment on Freshwater Mussels and Dragonflies in West Monponsett Pond: 2017 Monitoring*"

REPORT

Effects of an Alum Treatment on Freshwater Mussels and Dragonflies in West Monponsett Pond: 2017 Monitoring

prepared for

Solitude Lake Management
590 Lake Street, Shrewsbury, Massachusetts

prepared by

Biodrawversity LLC
206 Pratt Corner Road, Leverett, Massachusetts

January 2018

Shoreline of West Monponsett Pond in Halifax, Massachusetts.

INTRODUCTION

In 2013, a low-dose alum treatment was completed in the western basin of Monponsett Pond in Halifax, Massachusetts. At the request of the Massachusetts Natural Heritage and Endangered Species Program (NHESP), Lycott Environmental (now Solitude Lake Management) developed a Habitat Management Plan that included a plan to monitor the potential effects of the alum treatment on three state-listed aquatic species in the pond: *Leptodea ochracea* (Tidewater Mucket), *Ligumia nasuta* (Eastern Pondmussel), and *Neurocordulia obsoleta* (Umber Shadowdragon). Biodrawversity LLC was hired to complete the mussel and dragonfly monitoring, which included a pre-treatment study in 2013 and post-treatment monitoring in 2014.

The habitat management plan was revised in 2015 to allow for additional low-dose alum treatments. Three separate low-dose treatments were conducted in 2015, and one low-dose treatment was conducted in 2016, and Solitude staff completed basic mussel monitoring.

The Habitat Management Plan was revised again in 2017 to allow for a higher-dose treatment, which was completed in June of 2017. The revised plan specified that formal mussel monitoring (i.e., repeating the 2014 study) was to occur after treatment in 2017 (pending acceptable conditions), one-year post treatment (2018) and then again 5-years post treatment (2022). This report describes the pre-treatment surveys (2013) and post-treatment monitoring (2014 and 2017) completed to date. This report will be updated following completion of the post-treatment monitoring planned for 2018.

METHODS

I. Mussels

- The mussel survey was completed three times: (1) pre-treatment (May 23-24, 2013), (2) 1-year post-treatment (May 27-28, 2014), and 4-year post-treatment (June 28-29, 2017).
- The basic sampling unit was a 1 x 1 meter ($1m^2$) quadrat bounded by a frame, with two centerlines that divided the quadrat into four 0.5 x 0.5 meter sections. The centerlines facilitated more careful searching in the low-visibility environment. Quadrat locations were marked with underwater markers and recorded with GPS to enable the precise area of each to be resurveyed.
- Five quadrats were established at 10 sites (50

Figure 1. Locations of mussel monitoring sites (Sites 1-5, including shallow and deep plots at each site) and dragonfly survey sites (E-1, E-2, and W-1 to W-7) in West and East Monponsett Pond in Halifax, MA.

quadrats total); the 10 sites were paired (one shallow, one deep) at five locations in the pond (Figure 1, Table 1). The quadrats were arranged in a consistent pattern at each site (Figure 2).

- For each quadrat, biologists first conducted a visual and tactile search to count the number of mussels (all species) occurring at or near the surface. The biologists then excavated and sieved sediment from within one-fourth (0.25m^2) of the quadrat area to find buried mussels. Surface counts and buried counts were recorded for each species, and shell length was recorded for *L. ochracea* and *L. nasuta*. All mussels were placed back within the confines of the each quadrat.
- The following habitat information was recorded for each quadrat: water depth, spatial extent of each substrate type, and percent cover of macrophytes. During the two post-treatment surveys, biologists also counted freshly dead shells in addition to the steps described above.

Table 1. Locations and habitat parameters for each of the mussel monitoring sites in West Monponsett Pond. See Figure 1 for mapped locations. Water depth and substrate data are composite for the five quadrats at each location, since there very little variability in these parameters within each site from 2013 to 2017.

		Location*			Percent Cover					
Site	Plot Depth	Latitude	Longitude	Water Depth (ft)	Silt/Muck	Sand	Gravel	Cobble	Detritus	Vegetation
1	Shallow	42.01331	-70.85141	3.3	20	35	25	20	0	0
1	Deep	42.01334	-70.85120	5.7	25	25	40	10	30	0
2	Shallow	42.00918	-70.84885	3.3	15	65	20	1	1	1
2	Deep	42.00928	-70.84863	7.4	55	35	10	1	30	10
3	Shallow	42.00997	-70.84623	3.3	20	80	0	1	80	0
3	Deep	42.00997	-70.84641	7.4	20	80	1	0	50	0
4	Shallow	42.00738	-70.84306	3.3	60	30	5	5	10	0
4	Deep	42.00734	-70.84319	6.6	30	60	5	5	0	10
5	Shallow	42.00156	-70.84410	4.1	25	40	15	20	0	0
5	Deep	42.00157	-70.84415	6.6	25	55	15	5	15	1

*Coordinates are at centerpoint of the plot array.

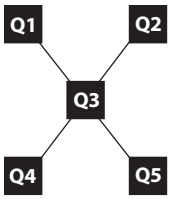

Figure 2. Spatial array of 5 1.0 m^2 quadrats (Q) at each site. Bricks were left on the lake bottom at Q1, Q2, Q4, and Q5; these were connected by strings and the intersection of the two strings marked the location of Q3. These were installed in 2013 and found again in 2014 and 2017.

II. Dragonflies

Dragonfly surveys, focusing on *N. obsoleta*, were completed just prior to or during peak emergence in late May to early July in 2013 and 2014, and in June 2017. Survey timing was intended to accommodate weather conditions to ensure that surveys were conducted under the best possible conditions. Notably, the spring of 2014 and 2017 was unusually cold and emergence was delayed 1-2 weeks.

Qualitative surveys of larvae, exuviae, and tenerals were conducted using a combination of aquatic D-net sweeps in or near aquatic vegetation and other submerged structure, snorkeling in shallow water to hand-pick larvae, and walking along the shoreline to look for exuviae and tenerals on the lakeshore (especially rocks, bridge abutments, and trees). The 2017 sampling focused primarily on exuviae and tenerals. The causeway between the West and East basins was surveyed most intensively, but other locations in West and East Monponsett Pond were also surveyed (Figure 1). Specimens were collected, preserved in alcohol, and identified under a dissecting microscope.

RESULTS

I. Mussels

Species Composition: Five mussel species were found during each of three surveys (Table 2). *E. complanata*, the dominant species, comprised 70.2, 80.9, and 76.5 percent of all individuals counted in 2013, 2014, and 2017, respectively. *L. ochracea*, the second-most common species, comprised 17.5,12.6, and 14.3 percent of all individuals counted in 2013, 2014, and 2017, respectively. The highest total count of *L. ochracea* was recorded in 2017, when 363 individuals were found. In all three years, *L. ochracea* was more numerous than *L. radiata*, *P. cataracta*, and *L. nasuta* combined. *L. nasuta* comprised 2.4, 1.1, and 1.8 percent of all individuals counted in 2013, 2014, and 2017 respectively. The highest count of *L. nasuta* was recorded in 2017, when 46 were found.

Species Density: Table 3 summarizes mussel density (mussels/m^2) for species, sites, and plot depths. Raw data are provided in Appendix 1. A total of 1,387 mussels were counted in 2013, 1,097 mussels were counted in 2014, and 2,536 mussels were counted in 2017. There was considerable among-site variation in mussel density; this was expected as different areas of a lake often have different mussel densities. There was also significant variation in mussel density due to water depth, despite only a 3-4 foot difference in water depth between "shallow" and "deep" plots. Shallow plots contained far higher density of mussels than deep plots (63.2 vs. 24.6 mussels/m^2 in 2013, 68.0 vs. 10.1 mussels/m^2 in 2014, and 117.2 vs. 24.8 mussels/m^2 in 2017), and this was consistent for all species and nearly all sites.

For all five species, densities were lower in 2014 than in 2013, and the overall density (all species) dropped slightly from 43.9 to 39.0 mussels/m^2. From 2013 to 2014, most of the observed decline was in deep plots, where mussel density dropped by 14.5 mussels/m^2 from 2013 to 2014, and the declining trend was consistent for all five species. In contrast, in shallow plots there was a modest increase of 4.8 mussels/m^2 from 2013 to 2014, and there was either an increase or no change for all species, except for *L. nasuta* that declined from 1.6 to 1.2 mussels/m^2.

Mussel densities were markedly higher in 2017 compared to 2013 or 2014, particularly for all species combined (71.0 mussels/m^2), but estimated density for all five species was also highest in 2017. The greatest change was for mussel density in the shallow plots, estimated at 117.2 mussels/m^2 in 2017 compared to 63.2 and 68.0 mussels/m^2 in 2013 and 2014, respectively. The density of mussels in the deep

Table 2. Total counts and percent composition of the five mussel species found during the mussel monitoring in West Monponsett Pond in 2013, 2014, and 2017.

	2013		2014		2017	
Species	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Elliptio complanata [Eastern Elliptio] [ElCo]	973	70.2	888	80.9	1,941	76.5
Lampsilis radiata [Eastern Lampmussel] [LaRa]	88	6.3	37	3.4	160	6.3
Pyganodon cataracta [Eastern Floater] [PyCa]	50	3.6	22	2.0	26	1.0
Leptodea ochracea [Tidewater Mucket] [LeOc]	243	17.5	138	12.6	363	14.3
Ligumia nasuta [Eastern Pondmussel] [LiNa]	33	2.4	12	1.1	46	1.8
Total	1,387		1,097		2,536	

Table 3. Average density of each mussel species, and for all species combined,from 2013 to 2017 at each monitoring site. The percent change (+ or -) is computed based on the departure from the 2013 density. See Appendix 1 and 2 for raw count and density data. Species abbreviated as in Table 2.

		E. complanata			*L. radiata*			*P. cataracta*			*L. ochracea*			*L. nasuta*			All Species			All Species, 2013-2017	
Site	Plot Depth	2013	2014	2017	2013	2014	2017	2013	2014	2017	2013	2014	2017	2013	2014	2017	2013	2014	2017	Difference	% Change
1	Shallow	60.6	78.8	99.0	3.0	5.2	5.4	3.4	1.6	0.4	4.4	6.6	5.2	2.4	1.2	1.6	73.8	93.4	111.6	37.8	51.2
1	Deep	17.0	4.0	5.2	3.8	1.2	1.2	1.4	0.0	0.0	0.4	3.2	2.6	0.0	0.0	1.2	22.6	8.4	10.2	-12.4	-54.9
2	Shallow	38.2	23.6	74.4	4.0	1.6	4.2	2.0	3.2	2.0	16.0	10.0	16.4	1.2	2.4	1.6	61.4	40.8	98.6	37.2	60.6
2	Deep	3.0	2.4	0.2	4.4	0.0	0.4	2.2	0.4	0.0	12.0	4.0	8.4	0.2	0.0	1.0	21.8	6.8	10.0	-11.8	-54.1
3	Shallow	78.8	107.4	141.4	4.6	5.4	9.6	1.0	1.6	2.8	6.8	14.2	19.6	1.0	1.8	0.6	92.2	130.4	174.0	81.8	88.7
3	Deep	42.4	6.0	27.2	3.0	0.2	1.2	0.2	0.6	1.2	7.8	5.8	12.4	1.0	0.2	1.2	54.4	12.8	43.2	-11.2	-20.6
4	Shallow	51.0	45.4	132.4	1.0	1.0	13.4	1.6	1.8	3.6	9.6	9.4	19.0	2.2	0.0	4.0	65.4	57.6	172.4	107.0	163.6
4	Deep	7.0	8.6	33.8	0.2	0.0	1.4	2.0	0.8	1.0	7.2	8.0	17.6	1.0	0.2	2.4	17.4	17.6	56.2	38.8	223.0
5	Shallow	18.8	13.8	22.2	0.4	2.2	3.0	1.0	0.8	2.0	1.4	0.0	2.2	1.4	0.8	0.2	23.0	17.6	29.6	6.6	28.7
5	Deep	3.2	1.6	1.8	0.4	0.2	0.6	1.2	0.8	0.0	1.6	2.4	1.6	0.4	0.0	0.2	6.8	5.0	4.2	-2.6	-38.2
Average Density		32.0	29.2	53.8	2.5	1.7	4.0	1.6	1.2	1.3	6.7	6.4	10.5	1.1	0.7	1.4	43.9	39.0	71.0	27.1	61.8
Average Density, Shallow		49.5	53.8	93.9	2.6	3.1	7.1	1.8	1.8	2.2	7.6	8.0	12.5	1.6	1.2	1.6	63.2	68.0	117.2	54.1	85.6
Average Density, Deep		14.5	4.5	13.6	2.4	0.3	1.0	1.4	0.5	0.4	5.8	4.7	8.5	0.5	0.1	1.2	24.6	10.1	24.8	0.2	0.7

Table 4. Average density (mussels/m^2) of each species at the sediment surface or buried (i.e., found by excavation) in 2013, 2014, and 2017; the ratio between surface (S) and buried (B) counts.

	Surface (S) Density			Buried (B) Density			S:B Ratio		
Species	2013	2014	2017	2013	2014	2017	2013	2014	2017
E. complanata	15.3	14.0	33.8	16.7	15.2	19.9	0.9	0.9	1.7
L. radiata	1.5	0.4	2.9	1.0	1.3	1.1	1.6	0.3	2.6
P. cataracta	0.8	0.2	0.3	0.8	1.0	1.0	1.0	0.2	0.3
L. ochracea	4.2	1.6	6.2	2.5	4.8	4.3	1.7	0.3	1.4
L. nasuta	0.5	0.1	0.8	0.6	0.6	0.6	0.9	0.2	1.2
All Species	22.4	16.2	44.0	21.5	22.8	27.0	1.0	0.7	1.6

Table 5. Shell length data for *L. ochracea* in 2013, 2014, and 2017.

	2013		2014		2017	
Length Class	Count	%	Count	%	Count	%
1 (<20.0 mm)	2	0.8	0	0.0	0	0.0
2 (20.0 - 29.9 mm)	3	1.2	11	7.9	8	2.2
3 (30.0 - 39.9 mm)	38	15.8	28	20.1	81	22.2
4 (40.0 - 49.9 mm)	162	67.2	68	48.9	147	40.3
5 (50.0 - 59.9 mm)	34	14.1	27	19.4	126	34.5
6 (60.0 - 69.9 mm)	2	0.8	5	3.6	3	0.8
7 (70.0 - 79.9 mm)	0	0.0	0	0.0	0	0.0
Length Statistics						
Total	241		139		365	
Mean Length (mm)	43.2		43.5		45.8	
Min Length (mm)	11.0		20.0		22.0	
Max Length (mm)	61.0		68.0		69.0	
Standard Deviation	6.12		9.16		7.86	

Table 6. Shell length data for *L. nasuta* in 2013, 2014, and 2017.

	2013		2014		2017	
Length Class	Count	%	Count	%	Count	%
1 (<20.0 mm)	0	0.0	0	0.0	0	0.0
2 (20.0 - 29.9 mm)	1	4.5	0	0.0	1	2.2
3 (30.0 - 39.9 mm)	2	9.1	4	33.3	11	23.9
4 (40.0 - 49.9 mm)	4	18.2	2	16.7	11	23.9
5 (50.0 - 59.9 mm)	11	50.0	5	41.7	16	34.8
6 (60.0 - 69.9 mm)	4	18.2	1	8.3	6	13.0
7 (70.0 - 79.9 mm)	0	0.0	0	0.0	1	2.2
Length Statistics						
Total	22		12		46	
Mean Length (mm)	51.5		46.4		47.7	
Min Length (mm)	24.0		30.0		20.0	
Max Length (mm)	64.0		64.0		75.0	
Standard Deviation	9.80		11.00		11.1	

plots was 24.8 mussels/m^2 in 2017, compared to 24.6 and 10.1 mussels/m^2 in 2013 and 2014, respectively.

Table 4 shows the mean density of each species at the surface or buried, and the ratio of surface animals to buried animals (S:B) for each species. For the ratio, values greater than one indicate a higher proportion of surface animals, values near one indicate similar proportions, and values below one indicate a higher proportion of buried animals. Generally, a higher proportion of mussels were found buried in 2014 compared to 2013 and 2017, especially for the four less common species. This was not true for *E. complanata* from 2013 to 2014, when the S:B ratio was nearly identical (0.9), but far higher numbers of *E. complanata* were found at the surface in 2017 (S:B ratio = 1.7).

The total count of excavated (buried) mussels

was fairly consistent among years (269, 285, and 338 for 2013, 2014, and 2017, respectively), whereas counts for mussels at the surface dropped from 1,118 to 812 (27.4 percent decline) from 2013 to 2014, and then increased to 2,198 in 2017. Most of the decline in surface counts from 2013 to 2014 occurred in deep plots (351 to 149, a 57.5 percent decline), compared to shallow plots (767 to 663, a 13.6 percent decline). The far higher number of mussels in 2017 was mostly comprised of mussels at the surface within shallow plots, where 1,827 were counted in 2017 compared to 767 in 2013 and 663 in 2014.

L. ochracea: A total of 243 *L. ochracea* were counted in 2013, 138 were counted in 2014, and 363 were counted in 2017. The ratio of surface to buried *L. ochracea* was 1.7 in 2013, 0.3 in 2014, and 1.4 in 2017. Overall density changed only slightly (6.7 to 6.4 mussels/m^2) from 2013 to 2014, but jumped to 10.5 mussels/m^2 in 2017. Table 5 provides shell length data for *L. ochracea* for all three years.

L. nasuta: A total of 33 *L. nasuta* were counted in 2013, 12 were counted in 2014, and 46 were counted in 2017. The ratio of surface to buried *L. nasuta* was 0.9 in 2013, 0.2 in 2014, and 1.2 in 2017. Overall density changed only slightly (1.1 to 0.7 mussels/m^2) from 2013 to 2014, and increased slightly to 1.4 mussels/m^2 in 2017. Table 6 provides shell length data for *L. nasuta* for all three years.

II. Dragonflies

Thirteen dragonfly species were documented during the study (Tables 7, 8). *Epitheca princeps* was the most common species encountered; other relatively common species (based on number of occurrences) included *Tetragoneuria cynosura*, *Perithemis tenera*, and *Macromia illinoiensis*. *N. obsoleta* was found in only two locations: within or near the box culvert separating West Monponsett from East Monponsett (found here in 2013, 2014, and 2017), and on riprap and a concrete retaining wall on the eastern side of East Monponsett Pond (2013 only).

Table 7. Dragonfly species documented in West and East Monponsett Pond during surveys from 2013 to 2017.

Species	Common Name	Abbreviation
Basiaeschna janata	Springtime Darner	BaJa
Dromogomphus spinosus	Black-shouldered Spinyleg	DrSp
Epitheca princeps	Prince Baskettail	EpPr
Erythemis simplicicollis	Eastern Pondhawk	ErSi
Gomphus sp.		GoSp.
Ladona julia	Chalk-fronted Corporal	LaJu
Libellula sp.		LiSp.
Macromia illinoiensis	Swift River Cruiser	MaII
Neurocordulia obsoleta	Umber Shadowdragon	NeOb
Pachydiplax longipennis	Blue Dasher	PaLo
Perithemis tenera	Eastern Amberwng	PeTe
Progomphus obscurus	Common Sanddragon	PrOb
Tetragoneuria cynosura	Common Baskettail	TeCy

The box culvert that separates East and West Monponsett Pond.

DISCUSSION

Mussels: There was considerable variation in mussel density estimates for all species among and within sites, with increases and decreases of similar magnitude from 2013 to 2014, and generally higher mussel density in 2017 compared to both 2013 and 2014 for all species except *P. cataracta*. The largest difference in mussel density from 2013 to 2014 was observed at Sites 1, 2 and 3, where there was an apparent large decline in mussel density in deep plots, though this was strongly influenced by counts of just one species, *E. complanata*. Similarly, there were some large increases in mussel density from 2013 to 2014 (e.g., Site 3-S with a 41.4 percent increase), and especially from 2014 to 2017, that are more difficult to explain.

Very few dead/dying mussels or recently dead shells were observed in 2014; therefore, the lower density of live mussels in some of the deep plots from 2013 to 2014 may not necessarily indicate mortality. Mussel densities were markedly higher in 2017 compared to 2014, and we are not certain whether this is due to actual population increases, or sampling bias. Factors that might contribute to variation in density estimates include movement, seasonal differences in detectability of each species (e.g., lower detectability of buried mussels), or insufficient samples sizes. Although the 2013 and 2014 studies were completed on similar dates, 2014 was a cooler spring and mussels may have been less active than they were at the same

Table 8. Dragonfly species found at each survey location and date in East and West Monponsett Pond, 2013 to 2017.

						Species**											
Pond	Site	Location	Date	Method	Stage*	BaJa	DrSp	EpPr	ErSi	GoSp.	LaJu	LiSp.	Mall	NeOb	PaLo	PeTe	PrOb	TeCy
East Monponsett	E-1	Riprap, East Side	6/19/13	Shoreline/Wading	E		X	X		X	X			X				X
East Monponsett	E-1	Riprap, East Side	6/21/17	Shoreline	E		X	X					X			X		X
East Monponsett	E-1	Riprap, East Side	6/28/17	Shoreline	E		X	X								X		X
East Monponsett	E-2	Causeway	6/17/13	Snorkeling/D-Net	L			X								X		
East Monponsett	E-2	Causeway	7/9/13	Shoreline/Wading	E		X	X			X					X		
East Monponsett	E-2	Causeway	5/27/14	Shoreline/Wading	E	X	X	X					X					X
East Monponsett	E-2	Causeway	6/30/14	Shoreline/Wading	E		X	X		X	X				X	X		X
East Monponsett	E-2	Causeway	6/20/17	Shoreline	E		X	X					X			X	X	X
East Monponsett	E-2	Causeway	6/28/17	Shoreline	E		X	X			X		X			X		X
West Monponsett	W-1	Causeway + Culvert	6/17/13	Snorkeling/D-Net	L			X					X		X	X		
West Monponsett	W-1	Causeway + Culvert	6/18/13	Shoreline/Wading	E			X					X	X				X
West Monponsett	W-1	Causeway + Culvert	7/9/13	Shoreline/Wading	E		X	X					X			X		
West Monponsett	W-1	Causeway + Culvert	5/27/14	Shoreline/Wading	E	X		X		X								X
West Monponsett	W-1	Causeway + Culvert	6/30/14	Shoreline/Wading	E, L		X	X					X	X	X	X		X
West Monponsett	W-1	Causeway + Culvert	6/20/17	Shoreline	E	X	X	X					X	X		X		X
West Monponsett	W-1	Causeway	6/28/17	Shoreline	E		X	X					X	X		X		X
West Monponsett	W-1	Culvert	6/28/17	Shoreline	E		X	X			X		X	X		X		X
West Monponsett	W-2	Boat Ramp	5/27/14	Shoreline/Wading	E								X					X
West Monponsett	W-2	Boat Ramp	6/30/14	Shoreline/Wading	E			X		X								
West Monponsett	W-2	Boat Ramp	6/21/17	Shoreline	E		X	X					X			X		X
West Monponsett	W-3	Eastern Shoreline	6/18/13	Shoreline/Wading	E			X										X
West Monponsett	W-4	Northern Shoreline	6/18/13	Shoreline/Wading	E			X					X					X
West Monponsett	W-5	Cranberry Outlet	6/30/14	Shoreline/Wading	E	X		X							X			X
West Monponsett	W-5	Cranberry Outlet	6/21/17	Shoreline	E	X	X	X	X				X		X	X		X
West Monponsett	W-6	Northwest Shoreline	6/30/14	Shoreline/Wading	E			X					X			X		
West Monponsett	W-7	Western Shoreline	6/30/14	Shoreline/Wading	E		X	X		X			X			X		X
West Monponsett	W-7	Western Shoreline	6/21/17	Shoreline	E			X					X			X		X

*E = Exuvia, L = Larva. **Species abbreviated as in Table 7.

time in 2013. Sampling was conducted one month later in 2017, and water clarity in West Monponsett Pond was the best we have ever observed, which may have contributed to higher mussel counts in 2017.

Overall, it is difficult to discern any adverse effects of the alum treatment on mussel density. There were some notable increases and decreases in mussel density from 2013 to 2014, and for the most part higher mussel densities in 2017 compared to 2013 and 2014. Video monitoring during treatment (2013) did not detect stress responses, such as gaping or movement. There were very few shells observed in 2014 that might explain some of the larger decreases in species counts from 2013 to 2014. Juvenile mussels are considered more sensitive to stressors than adults, but very few juveniles were ever detected in the quantitative sampling. In summary, data do not indicate that the alum treatment had any adverse effect on juveniles or adults of any mussel species. Perhaps more importantly, the 2017 data suggest that the mussel community in West Monponsett Pond is doing as well, or better, than it has in the last four years despite periodic challenging environmental conditions.

Dragonflies: Results were consistent with the 2011 baseline report that found only four *N. obsoleta* exuviae within the box culvert between West and East Monponsett, and no *N. obsoleta* larvae or adults elsewhere in the pond. This report also documents *N. obsoleta* on the far eastern side of East Monponsett Pond, in habitat similar to the causeway and box culvert. Due to low densities and limited habitat availability for *N. obsoleta* in West Monponsett Pond, this was a qualitative presence/absence study to determine if *N. obsoleta* could be detected emerging after the alum treatment. Both the 2013 and 2014 dragonfly surveys were conducted after the 2013 alum treatment, and *N. obsoleta* and other species were detected within or near the box culvert on both years, and also in 2017.

REPORTS CITED

GZA GeoEnvironmental, Inc. 2011. Mussel & Dragonfly Baseline Survey, West Basin Monponsett Pond. Reported submitted to Lycott Environmental Inc. and the Town of Halifax, MA. Report prepared in partial response to requirements of NHESP Tracking No 09-27490.

Appendix 1: Raw Mussel Count Data

Site = site number (1-5); Plot: S = shallow plot, D = deep plot; Quad = quadrat number (5 per plot); Position: Surf = surface count, Exc = excavated count; mussel species abbreviated as in Table 2.

				2013					2014					2017				
Site	Plot	Quad	Position	ElCo	LaRa	PyCa	LeOc	LiNa	ElCo	LaRa	PyCa	LeOc	LiNa	ElCo	LaRa	PyCa	LeOc	LiNa
1	S	1	Surf	10	2	0	0	0	34	1	0	0	0	84	5	0	7	1
1	S	1	Exc	9	0	0	2	0	10	1	0	2	0	6	0	0	1	0
1	S	2	Surf	10	2	0	0	0	24	1	0	1	0	65	1	0	2	0
1	S	2	Exc	14	2	1	3	0	7	0	0	1	0	4	0	0	0	0
1	S	3	Surf	14	2	0	1	12	31	0	0	0	2	88	6	2	1	0
1	S	3	Exc	14	0	2	0	0	11	0	1	0	0	0	0	0	0	1
1	S	4	Surf	22	0	1	0	0	39	3	0	0	0	95	6	0	1	2
1	S	4	Exc	13	0	0	0	0	16	2	0	3	0	3	0	0	1	0
1	S	5	Surf	7	1	0	1	0	46	1	0	0	0	79	1	0	3	1
1	S	5	Exc	10	0	1	0	0	11	2	1	2	1	8	2	0	1	0
1	D	1	Surf	4	0	0	0	0	4	1	0	0	0	7	0	0	3	1
1	D	1	Exc	3	1	0	0	0	0	0	0	3	0	0	0	0	0	0
1	D	2	Surf	2	2	1	0	0	2	0	0	2	0	6	0	0	1	1
1	D	2	Exc	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1	D	3	Surf	15	5	0	1	0	2	3	0	2	0	6	3	0	0	1
1	D	3	Exc	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	D	4	Surf	3	0	2	1	0	4	2	0	0	0	3	1	0	4	0
1	D	4	Exc	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0
1	D	5	Surf	5	0	0	0	0	4	0	0	0	0	4	2	0	5	3
1	D	5	Exc	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	S	1	Surf	16	1	0	2	0	3	0	0	1	0	62	2	0	9	0
2	S	1	Exc	4	1	0	4	0	3	0	0	0	3	9	0	0	4	1
2	S	2	Surf	7	1	0	1	0	14	0	0	2	0	66	4	1	8	1
2	S	2	Exc	11	1	0	5	0	4	2	0	2	0	6	0	0	3	0
2	S	3	Surf	23	0	1	6	0	7	0	0	1	0	49	2	0	0	1
2	S	3	Exc	4	1	0	3	0	4	0	2	1	0	5	0	0	1	0
2	S	4	Surf	12	2	0	3	2	3	0	0	1	0	54	3	1	7	0
2	S	4	Exc	4	0	2	2	0	5	0	0	4	0	0	1	0	2	0
2	S	5	Surf	13	4	1	12	0	7	0	0	1	0	49	6	0	6	2
2	S	5	Exc	7	0	0	0	1	5	0	2	4	0	3	0	2	3	0
2	D	1	Surf	1	2	3	6	1	0	0	0	0	0	0	0	0	16	0
2	D	1	Exc	2	2	1	3	0	0	0	0	0	0	0	0	0	0	0
2	D	2	Surf	1	2	1	10	0	0	0	1	0	0	0	0	0	4	0
2	D	2	Exc	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	D	3	Surf	0	2	1	6	0	0	0	1	0	0	1	0	0	9	2
2	D	3	Exc	0	1	0	1	0	0	0	0	3	0	0	0	0	0	0
2	D	4	Surf	1	2	0	7	0	0	0	0	0	0	0	0	0	4	1
2	D	4	Exc	0	0	0	2	0	2	0	0	2	0	0	0	0	0	0
2	D	5	Surf	0	2	2	7	0	0	0	0	0	0	0	2	0	5	2
2	D	5	Exc	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
3	S	1	Surf	68	3	0	8	0	62	0	0	0	0	63	8	0	2	0
3	S	1	Exc	3	1	0	1	0	11	2	1	4	1	10	1	2	1	0
3	S	2	Surf	46	5	2	4	0	45	0	0	0	1	79	4	1	5	0
3	S	2	Exc	3	0	0	1	0	6	1	1	2	0	26	2	1	5	0
3	S	3	Surf	44	2	1	5	1	61	1	0	1	0	58	6	0	4	1
3	S	3	Exc	2	0	0	0	0	7	0	0	4	1	12	0	0	4	0
3	S	4	Surf	58	5	0	5	0	69	0	0	0	0	63	7	1	5	1
3	S	4	Exc	5	0	0	0	0	23	2	0	4	0	18	0	0	4	0
3	S	5	Surf	74	4	2	4	0	72	2	0	2	0	96	11	0	6	1
3	S	5	Exc	13	0	0	0	1	10	1	0	3	0	21	0	0	5	0
3	D	1	Surf	7	0	0	4	0	5	0	2	3	0	16	2	1	12	2
3	D	1	Exc	4	0	0	0	1	0	0	0	0	0	2	0	0	0	0
3	D	2	Surf	5	0	0	5	0	3	0	0	8	1	14	1	1	10	2
3	D	2	Exc	3	0	0	0	0	0	0	0	0	0	13	0	1	3	0
3	D	3	Surf	17	2	0	7	0	3	1	0	3	0	8	0	0	5	0

Appendix 1 (continued)

				2013					2014					2017				
Site	Plot	Quad	Position	ElCo	LaRa	PyCa	LeOc	LiNa	ElCo	LaRa	PyCa	LeOc	LiNa	ElCo	LaRa	PyCa	LeOc	LiNa
3	D	3	Exc	5	0	0	0	0	1	0	0	0	0	1	0	0	0	0
3	D	4	Surf	76	10	1	17	0	2	0	0	5	0	12	1	0	12	2
3	D	4	Exc	8	0	0	0	0	1	0	0	0	0	2	0	0	0	0
3	D	5	Surf	15	3	0	6	1	5	0	1	10	0	6	2	0	11	0
3	D	5	Exc	3	0	0	0	0	1	0	0	0	0	2	0	0	0	0
4	S	1	Surf	15	1	3	5	1	15	0	0	1	0	83	5	0	9	1
4	S	1	Exc	9	0	1	1	1	10	1	0	4	0	8	0	1	2	0
4	S	2	Surf	22	0	0	8	2	12	0	0	0	0	46	6	0	6	0
4	S	2	Exc	6	0	0	2	0	5	0	0	1	0	14	2	1	2	0
4	S	3	Surf	19	2	0	4	0	14	0	0	1	0	104	8	0	5	2
4	S	3	Exc	4	0	0	0	0	4	0	0	4	0	11	3	2	1	1
4	S	4	Surf	27	1	1	7	0	29	1	1	0	0	78	16	1	16	0
4	S	4	Exc	9	0	0	0	1	7	0	2	2	0	16	1	0	1	2
4	S	5	Surf	36	1	0	12	0	21	0	0	1	0	119	8	1	19	1
4	S	5	Exc	6	0	0	0	0	8	0	0	0	0	9	0	0	4	1
4	D	1	Surf	1	0	1	9	0	12	0	2	12	0	7	0	0	13	1
4	D	1	Exc	0	0	0	0	0	2	0	0	2	0	0	0	1	0	0
4	D	2	Surf	1	0	0	5	0	4	0	2	2	0	25	2	1	18	0
4	D	2	Exc	0	0	0	0	0	1	0	0	0	0	13	0	0	1	1
4	D	3	Surf	3	0	3	5	0	0	0	0	4	0	5	0	0	11	2
4	D	3	Exc	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0
4	D	4	Surf	1	0	3	10	0	4	0	0	8	1	12	3	0	13	1
4	D	4	Exc	1	0	0	0	1	1	0	0	0	0	7	0	0	2	0
4	D	5	Surf	1	1	3	7	1	3	0	0	6	0	8	2	0	13	0
4	D	5	Exc	3	0	0	0	0	1	0	0	0	0	7	0	0	2	1
5	S	1	Surf	17	0	1	1	2	4	1	0	0	0	16	0	1	1	1
5	S	1	Exc	3	0	0	0	0	2	0	0	0	0	2	1	1	0	0
5	S	2	Surf	10	0	4	2	1	4	0	0	0	0	20	2	0	6	0
5	S	2	Exc	1	0	0	0	0	2	1	1	0	1	2	0	0	0	0
5	S	3	Surf	11	2	0	0	0	5	1	0	0	0	8	3	0	3	0
5	S	3	Exc	1	0	0	0	1	2	0	0	0	0	3	0	0	0	0
5	S	4	Surf	12	0	0	0	0	5	0	0	0	0	12	1	0	1	0
5	S	4	Exc	2	0	0	0	0	2	0	0	0	0	3	0	0	0	0
5	S	5	Surf	4	0	0	0	0	7	1	0	0	0	11	1	1	0	0
5	S	5	Exc	3	0	0	1	0	3	1	0	0	0	1	1	1	0	0
5	D	1	Surf	2	1	1	2	1	2	0	0	0	0	2	0	0	0	0
5	D	1	Exc	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5	D	2	Surf	2	0	0	1	0	0	0	0	0	0	0	1	0	3	1
5	D	2	Exc	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5	D	3	Surf	1	1	1	1	0	0	0	0	0	0	2	1	0	3	0
5	D	3	Exc	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
5	D	4	Surf	1	0	0	1	0	2	0	0	0	0	0	0	0	1	0
5	D	4	Exc	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	D	5	Surf	2	0	0	3	1	4	1	0	0	0	1	1	0	1	0
5	D	5	Exc	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0
				973	88	50	243	33	888	37	22	138	12	1941	160	26	363	46

West Monponsett Pond

Halifax/Hanson, Massachusetts
2018 Year-End Alum Treatment Report

Prepared for:
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Table of Contents

Appendices

I. INTRODUCTION

Monponsett Pond located in the towns of Halifax and Hanson, Massachusetts, is a significant ecological, historical, and recreational resource as well as an important supplementary water supply component for the nearby City of Brockton. The 528-acre pond is bisected by Route 58, which splits the water body into two basins - East and West - directly connected by a small culvert in the Southern portion of the pond. Both basins are highly developed with residential homes and receive inputs from a suburban watershed of approximately six square miles.

As a whole, Monponsett Pond has been heavily impacted by the use of its waters and watershed, and both basins have been listed as Category 5 "Impaired" waterbodies on the Massachusetts Integrated List of Waters (303(d) list). The East Basin was listed for nuisance aquatic plants and mercury in fish. A TMDL was approved by the EPA for mercury, thus removing the basin from the list of impaired waters. The Western basin appears on the 2014 303(d) list as a category 5 water body for nutrients, noxious aquatic plants, transparency, and exotic species. The West Basin was included in the mercury TMDL and a draft TMDL for phosphorus was released in November of 2016.

Both basins, especially the West Basin, have been subject to extensive nuisance algae blooms (specifically cyanobacteria – blue-green algae) for many years. During recent summers, these blooms prompted the frequent closure of the Western basin to swimming and boating. Algae testing has been carried out both by the Massachusetts Department of Public Health (MA DPH) and Massachusetts Department of Environmental Protection (MA DEP) throughout the summer months. MA DPH also conducted analysis of water quality, including total phosphorus. These results show a definite correlation between concentration of total phosphorus and total algal cell count in the Western basin throughout the summer. Previous testing and the TMDL have determined that internal loading of phosphorus is prominent in the West Basin, along with watershed loading.

Despite these water quality challenges, the Western basin has been identified as an area of priority habitat by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Program (NHESP). Three state-listed species of special concern have been confirmed in West Monponsett Pond: Tidewater Mucket (*Leptodea ochracea*), Eastern Pondmussel (*Ligumia nasuta*), and Umber Shadowdragon (*Neurocordulia obsoleta*).

Internal Phosphorus Management

Understanding the correlation between phosphorus levels and growth of potentially harmful cyanobacteria, the Town of Halifax, in cooperation with MA DEP, has investigated and implemented phosphorus management activities in West Monponsett Pond**.**

Various parties have been addressing watershed phosphorus loading including efforts by nearby cranberry bogs. Work focusing on internal phosphorous inactivation began in 2013, under Lycott Environmental, in accordance with the NHESP letter (09-27490) dated June 6, 2012, and the submitted Habitat Management Plan. In that year, a volumetric dose of 3.0 ppm Al was applied in one treatment for a total areal (sediment) dose of 7.1 g/m2. No treatment occurred in 2014, and in 2015 the dose and method were changed to a total of 2.1 ppm Al over three treatments (0.7 ppm each), resulting in an additional sediment dose of 4.9 g/m2 Al. The 2016 season saw one application of 1.4 ppm Al, depositing 3.2 g/m2 Al on the pond bottom. Prior to 2017, a total of 15.2 g/m2 of aluminum have been applied to the bottom of the Western basin.

Following award of a Section 319 Grant to the Town of Halifax and revision of the Habitat Management Plan with NHESP, 17.0 g/m2 (~8 ppm Al) was applied to the West Basin in June of 2017. Despite this significant dose, the pond was still closed for a portion of the 2017 season due to high cyanobacteria counts along the shoreline

even though algae counts and phosphorous levels overall showed a significant improvement. For 2018, the plan was to apply an additional 10 g/m2 to the West Basin. Past treatments have sequentially reduced phosphorus levels in the West Basin and it was estimated that the proposed treatment will continue progress towards meeting WQ goals. With the proposed treatment in 2018, the total sediment dose applied to West Monponsett Pond is now 42.2 g/m2.

Based on experience in similar lakes and the assessment of sediment phosphorus release, a sediment dose of up to 50 g/m^2 is likely to be needed in order to sufficiently reduce internal phosphorus recycling for an extended period of time. The ongoing sediment release, in addition to annual watershed loading, has resulted in reduced efficacy of the past treatments in controlling nuisance bloom conditions, but phosphorus levels and overall conditions have been improving with each sequential dose applied to the pond.

II. PERMITTING

U.S. Environmental Protection Agency National Pollution Discharge Elimination System Permit

Lycott Environmental filed an electronic Notice of Intent (eNOI) under the U.S. Environmental Protection Agency Pesticide General Permit (PGP) for the application of pesticides to the Monponsett Ponds on behalf of the Town of Halifax on May 9, 2012. This application was signed and submitted by the Town of Halifax on May 19, 2013, which then received an active status ten days following its submission. The NOI remains valid through 2018 and will be extended as necessary.

Massachusetts Endangered Species Act Project Review

A 'REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond' was submitted to the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Review Program (NHESP) on March 27, 2017. The NHESP provided approval correspondence on May 4, 2017. This revised plan covered work up through the 2018 treatment.

Order of Conditions

The Orders of Conditions (Halifax & Hanson) have been automatically extended by the Permit Extension Act and are therefore valid for an additional four years from the original date of expiration or until June 2019. Revised alum treatment plans were presented to both Commissions in the spring of 2017. Requests for Extensions will need to be made with the Commission to allow work to continue past June 2019.

Massachusetts Department of Environmental Protection License to Apply Chemicals

SLM prepared and filed for the required License to Apply Chemicals permit from MA DEP Office of Watershed Management; the approved license was issued on May 14, 2018 (#18282).

Image 1: Treatment Vessel

III. 2018 TREATMENT PROGRAM CHRONOLOGY

The tasks performed as part of the 2018 treatment program are outlined below.

- Received approved MA DEP License to Apply Chemicals 5/14/2018
- Alum treatment 5/15 – 5/18/2018

IV. TREATMENT LOGISTICS

Alum applications were administered throughout four (4) days: May 15th through May 18th. The applications were conducted with a specially equipped treatment vessel (**Image 1**). The treatment vessel was equipped with

2 translucent polyethylene tanks, in addition to a fathometer, speedometer, in-line pressure gauges and flowmeters to measure and ensure appropriate chemical delivery. Two separate pumping systems were used to apply aluminum sulfate and sodium aluminate to areas greater than 4' in depth in the West Basin of Monponsett Pond, an area totaling 235 acres. The 235-acre treatment area was divided into three pre-determined treatment zones (**Image 2**) with similar depth characteristics in order to ensure accurate dosing and a more uniform application of the alum and sodium aluminate. An areal dose of 10 g/m^2 was applied to each treatment area. Over the course of the four-day treatment, a total of 19,000 gallons of aluminum sulfate and 9,500 gallons of sodium aluminate were applied to West Monponsett Pond. A map of the treatment vessel tracks from the entire treatment event is provided in **Image 3**.

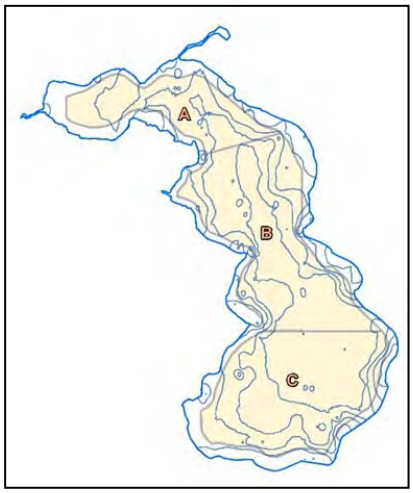


Image 2: Treatment Zones of the Western Basin of Monponsett Pond

Image 3: 2018 Alum Treatment tracks

V. MONITORING PROGRAM

The following table outlines the major components of the monitoring program and their respective goals, as approved in the habitat management plan ('**Appendix A**'). Mussel monitoring was conducted following treatment in 2017 and, based on the revised Habitat Management Plan, no further mussel monitoring is required until one year after alum treatments have ceased.

Table 1. Monitoring program design

Monitoring component	Timing in relation to treatment	Location(s)	Goals
Water Quality	Before, during and after application	Established location within each treatment zone	Evaluate short and long-term effects on water quality
	Monthly		Monitor summer long water quality and algae conditions

a. WATER QUALITY MONITORING

The water quality monitoring was comprised of sample collection for laboratory analysis and basic *in-situ* testing. Water quality samples were collected at predetermined locations within each treatment area immediately before the May treatment event, as well as once a month for four months after the treatment. Each sample was analyzed for: water clarity, pH, turbidity, alkalinity, total phosphorus, and dissolved phosphorus ('**Appendix B, Table 1**'). The *in-situ* treatment testing was performed at the same predetermined

locations before, during and after each treatment day. The testing included temp/dissolved oxygen, water clarity, pH, and alkalinity ('**Appendix B, Table 2**').

Total Phosphorus Monitoring

A total phosphorus measurement was collected monthly from May through October (**Figure 1**). The May sample was collected prior to the treatment. Total phosphorus levels decreased overall following the treatment event, but spiked in August before decreasing again in October. The results show a reduction in total phosphorus of over 50% (Avg. 23 ppb May – <10 ppb at all stations in October) during the course of the season. All samples in October were below the detection limit of 10 ppb.

Figure 1: Comparison of total phosphorous (ppb) from May to October

Dissolved Phosphorus Monitoring

A dissolved phosphorus measurement was also collected at each station starting before the treatment, through October (**Figure 2**). Dissolved phosphorus levels were varied from 10-17 ppb prior to treatment, were below detection in June, spiked in July and August at varied station before coming in below detection limits in October. Overall, the results show a significant reduction in dissolved phosphorus during the course of the season.

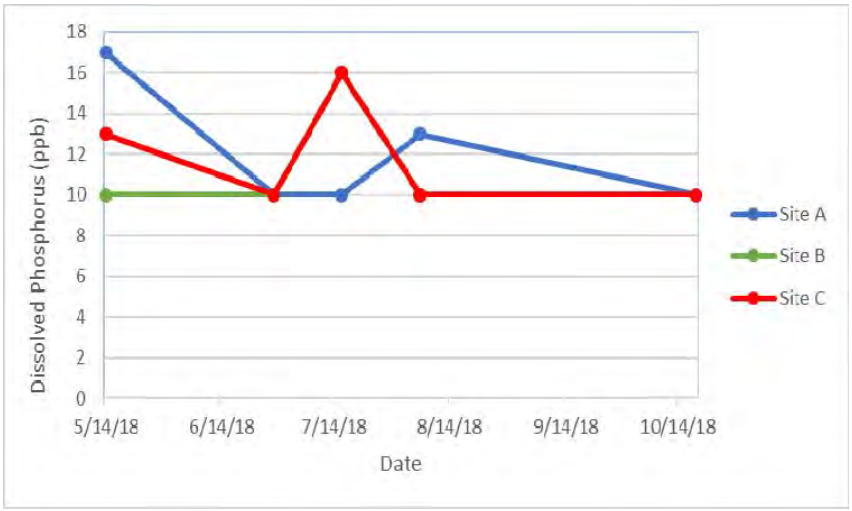


Figure 2: Comparison of dissolved phosphorus (ppb) from May to October

Dissolved Oxygen Monitoring

A dissolved oxygen measurement was collected once a month from May to October (**Figure 3**). A slight increase in dissolved oxygen was observed following the May treatment event; however, levels later decreased, before increasing again at the final measurement. The dissolved oxygen measurements revealed that levels remained within a suitable range (> 5 mg/L) for wildlife populations throughout the duration of the program and were not substantially impacted by the buffered alum treatments.

Figure 3: Average dissolved oxygen (mg/L) sampling results of Site B from May to October.

Water Clarity Monitoring (via Secchi Disk)

Water clarity was measured before, during and after each day of the May treatment event (Appendix A - Table 2), and subsequently once per month until October (**Figure 4**). Throughout the four days of the treatment event, the Secchi depth stayed relatively stable between 7 and 8 feet. Clarity improved in July, before decreasing in August. The reduction in water clarity (Secchi depth) in August correlates with an increase in algal cell density.

Figure 4: Average Secchi Disk depth (ft.) results of all three treatment zones throughout May treatment event and the following 5 months.

pH Monitoring

A pH measurement was collected before, during and after each day of the May treatment (Appendix A - Table 2) event as well as monthly through October. (**Figure 5**). Overall, the results show relatively constant pH levels between 6.5 and 7 SU, with minimal fluctuation throughout the treatment event.

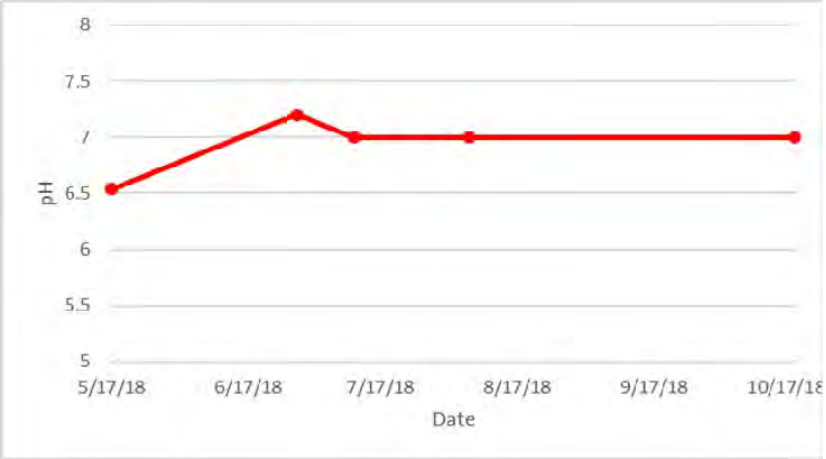


Figure 5: Average pH results of all three treatmert zones from May to October.

Total Alkalinity Monitoring

Total alkalinity was measured before, during and after each day of the May treatment event, and subsequently once per month until October (**Figure 6**). The total alkalinity measurements remained between approximately 10 and 12 mg/L throughout the treatment event, with some fluctuation between each day. In the following months the total alkalinity steadily increased, before plateauing.

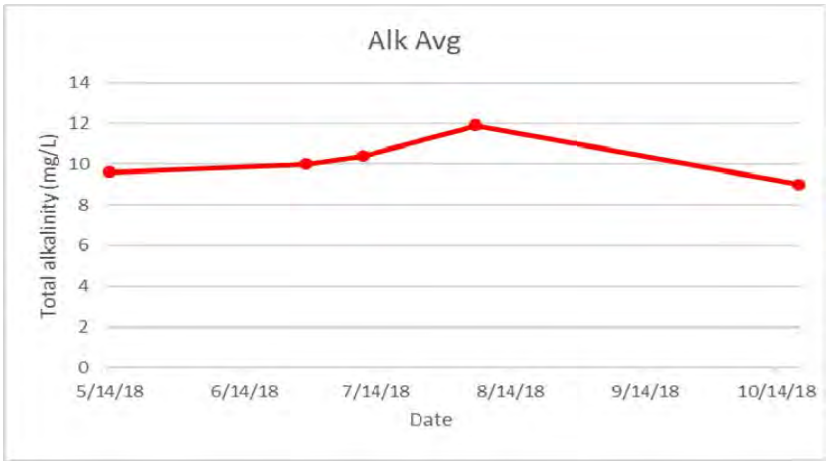


Figure 6: Average total alkalinity (mg/L) results of all three treatment zones from May to October.

b. ALGAE SAMPLING

A single monthly sample (May-October) was collected from Area B within the West Basin for algae species identification and characterization of general species abundance/dominance. Based on the results of these samples the algae assemblage presented a fair amount of variance from month to month. See **Table 1** for a breakdown of the natural count/mL of each phylum of algae observed in the monthly samples.

Table 1:	**Phylum of Algae (Natural Unit Count/mL)**				
Date	**Diatomaceae**	**Rotifera**	**Chlorophyceae**	**Cyanophyceae**	**Protozoa**
5/14/18	41	-	59	-	103
6/28/18	112	-	40	18	370
7/11/18	350	-	-	1,480	1,365
8/6/18	595	-	140	1,845	70
10/19/18	115	-	-	66	-

Overall phytoplankton growth was low in May and June. Cell density increased in July and August, with cyanobacteria comprising the majority of the increase along with Protozoa in July. Overall density remained low. The most abundant and frequently observed blue-green algae were *Chroococcus, Gomphosphaeria and Microcystis.* The blue-green algae cell count fluctuated throughout the 2018 management season, but never exceeded 10,000 cell/ml at anytime. (**Figure 7**).

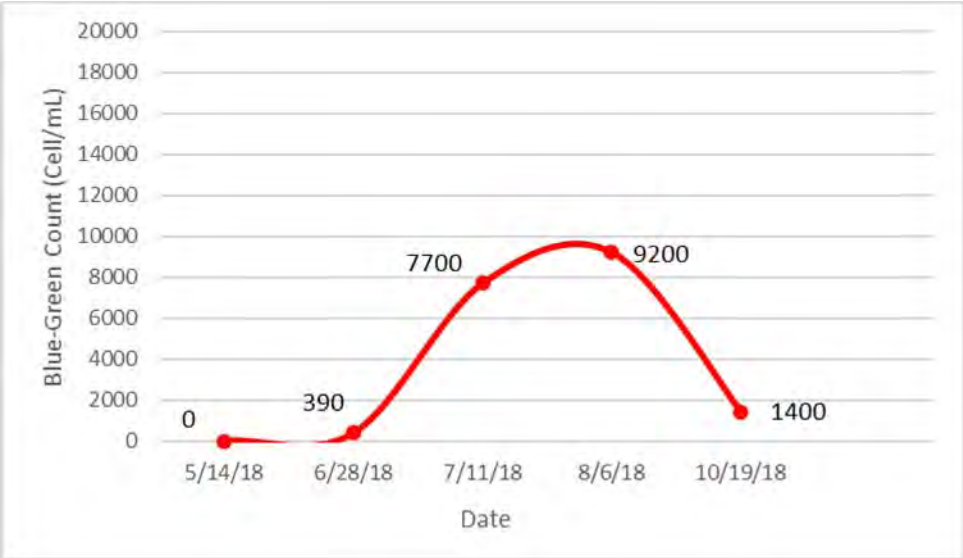


Figure 7: Blue-Green Count/mL from May to October.

VI. DISCUSSION/CONCLUSION

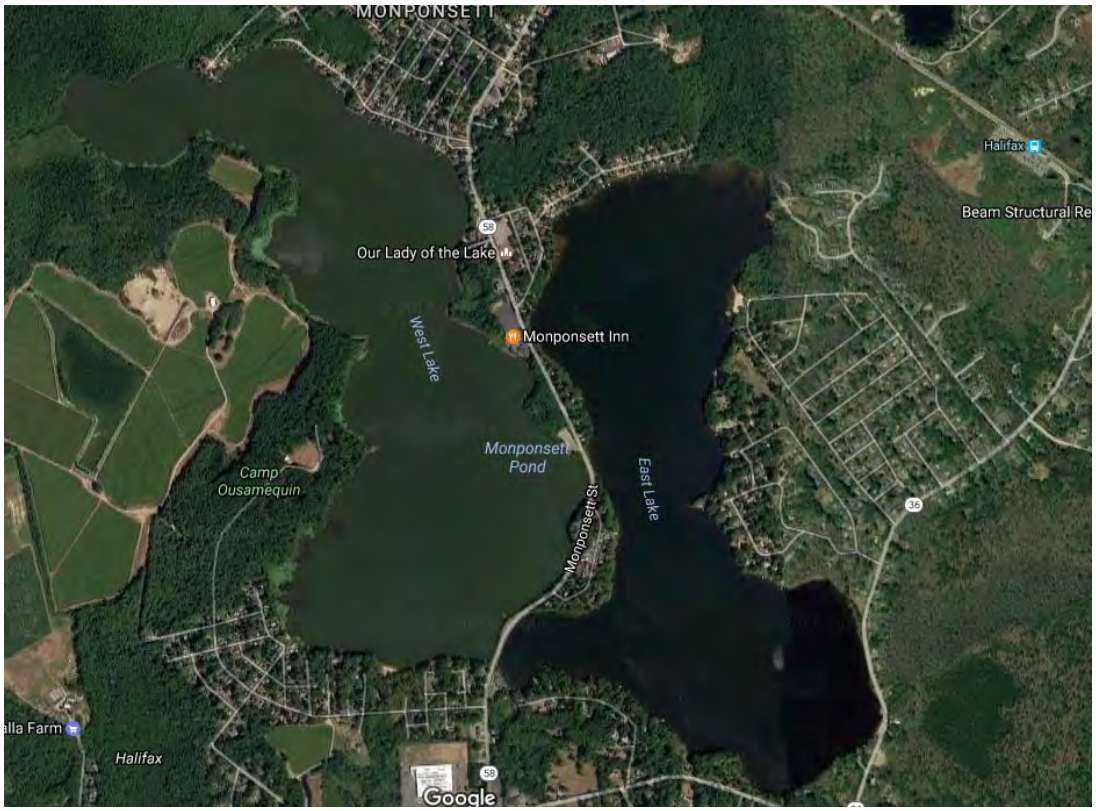
Overall, the 2018 alum treatment at West Monponsett Pond was conducted successfully and with no adverse effects on water quality or non-target organisms. The treatment served to apply an additional 10 g/m^2 of aluminum to the sediment in order to further counteract internal phosphorus loading. Monthly water quality sampling showed overall improvements in phosphorus concentrations, water clarity and algae populations as compared to previous years and the West Basin was not closed to recreation at any point this summer.

We understand that the Town is working with MassDEP to fund another round of alum treatment at the West Basin, and possibly the East Basin in 2019. Another round of treatment in 2019 should bring the applied dose up to the target 50 g/m2 and will hopefully preserve the great conditions seen on the pond in 2018.

Appendix A

REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond

REVISED Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond (2017)



Applicant: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Representative: SOLitude Lake Management
590 Lake Street
Shrewsbury, MA 01545

TABLE OF CONTENTS

REVISED Habitat Management Plan for Phosphorus Inactivation in the West Basin of Monponsett Pond Halifax/Hanson, Massachusetts 2017

SITE DESCRIPTION & BACKGROUND

Monponsett Pond, located in the towns of Halifax and Hanson, Massachusetts, is a significant ecological, historical, and recreational resource as well as an important supplementary water supply for the nearby City of Brockton. The 528-acre pond is bisected by Route 58, which splits the water body into two basins - East and West - directly connected by a small culvert in the Southern portion of the pond. Both basins are highly developed with residential homes, and receive inputs from a suburban watershed of approximately 6 mi^2.

As a whole, Monponsett Pond has been heavily impacted by the use of its waters and watershed, and both basins have been placed on the Massachusetts Integrated List of Waters (303(d) list). Since 2010, the Eastern basin has been categorized as a 4c water body for presence of exotic species and a Total Maximum Daily Load (TMDL) was published in 2007 for high concentrations of mercury. The Western basin appears on the 2010 303(d) list as a category 5 water body for nutrients, noxious aquatic plants, turbidity, and exotic species. A draft TMDL for phosphorus was released in November of 2016. The presence of two exotic aquatic vegetation species; Fanwort (*Cabomba caroliniana*) and Variable Milfoil (*Myriophyllum heterophyllum*), have been recorded in the Eastern basin, while presence of Fanwort was noted in the Western basin.

Both basins have also been subject to extensive nuisance algae blooms (specifically cyanobacteria – blue-green algae) for many years. During recent summers, these blooms prompted the frequent closure of the Western basin to swimming and boating. Algae testing has been carried out both by the Massachusetts Department of Public Health (MA DPH) and Massachusetts Department of Environmental Protection (MA DEP) throughout the summer months. MA DPH also conducted analysis of water quality, including total phosphorus. These results show a definite correlation between concentration of total phosphorus and total cell count in the Western basin throughout the summer.

Despite these water quality challenges, the Western basin has been identified as an area of priority habitat by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Program (NHESP). Three state-listed species of special concern has been confirmed in West Monponsett Pond: Tidewater Mucket (*Leptodea ochracea*), Eastern Pondmussel (*Ligumia nasuta*), and Umber Shadowdragon (*Neurocordulia obsoleta*).

PROPOSED PHOSPHORUS INACTIVATION PROGRAM

This phosphorous inactivation project began in 2013, under Lycott Environmental, in accordance with the NHESP letter (09-27490) dated June 6, 2012, and the submitted Habitat Management Plan. In that year, a volumetric dose of 3.0 ppm Al was applied in one treatment for a total areal (sediment) dose of 7.1 g/m^2. No treatment occurred in 2014, and in 2015 the dose and method was changed to a total of 2.1 ppm Al over three treatments (0.7 ppm each), resulting in an additional sediment dose of 4.9 g/m^2 Al. The 2016 season saw one application of 1.4 ppm Al, depositing 3.2 g/m^2 Al on the pond bottom. To date a total of 15.2 g/m^2 of aluminum has been applied onto the pond bottom.

Table 1-Historical Dosing Information

Treatment Year	Volumetric Dose	Areal Dose	Notes
2013	3.0 ppm	7.1 g/m^2	Single application
2015	2.1 ppm	4.9 g/m^2	Split over three applications
2013	1.4 ppm	3.2 g/m^2	Single application
Total Areal Dose Applied		**15.2 g/m^2**	

Based on experience in other similar lakes and assessments of the sediment phosphorus release, a sediment dose of up to 50 g/m^2 is likely to be needed in order to sufficiently reduce internal phosphorus recycling. This ongoing sediment release in addition to annual watershed loading has resulted in reduced efficacy of the current treatment plan on controlling nuisance bloom conditions. Based on recent discussion with Mark Mattson (MassDEP) modifications to the management plan are proposed. As a note, based on the recent phosphorus TMDL draft, alum treatment may be conducted in the East Basin of Monponsett Pond at a reduced dose, however no listed species have been identified in that basin.

Aluminum Dose Modification

In 2017, the alum treatment plan will involve at least one large scale, early season application of 9.0 g/m^2 (~4 ppm Al) with the hope of inactivating a sufficient amount of available phosphorous in the pond sediments to provide desirably low growth of cyanobacteria. Past treatments have sequentially reduced phosphorus levels in the West Basin and it is estimated that the proposed treatment will meet WQ goals at least for a period of time. Depending on available resources, the dose may be increased up to 17.0 g/m^2 as a single or split-application treatment in 2017. Depending on how dramatically conditions improve in the lake, subsequent applications may not be necessary, however the remaining dose (up to the projected total dose of 50 g/m^2) may be applied in 2018 or plans and grants are also being pursued for an alum micro-floc injection system. The benefit of the injection system is that it will be in place to provide an option for addressing continued watershed phosphorus loading on an on-going basis. A summary of the 2017 treatment results and monitoring data will be supplied to NHESP in the fall, to facilitate their review of any proposed treatments in 2018.

Table 2-Proposed Alum Treatments for West Monponsett Pond

Treatment Year	Areal Dose	Notes
2017	9.0-17 g/m^2	Single or split application – any increase above 9 g/m^2 is pending funding and determination of need.
2018	Up to 17 g/m^2	Single or split application – only applied if needed after assessing results of 2017 treatments and pending funding. Also pending review by NHESP.

Treatment Area

No change to the overall extent of the treatment area is proposed. As with the 2013/2015-2016 treatment program, the aluminum sulfate and sodium aluminate will be applied to areas of the West Basin that are deeper than four (4) feet – a total treatment area of approximately 235 acres. We are proposing to divide the overall treatment area into three zones with relatively uniform depth characteristics (Zone A – 45 acres; Zone B – 98 acres; Zone C – 92 acres). This approach will enable accurate dosing and more uniform application without increasing the risk to rare species.

Application Methodology

Treatment will be conducted with our specially equipped treatment vessel. The treatment vessel will be equipped with a fathometer and speedometer. The use of the speedometer enables us to prepare calibration table for chemical delivery (gal/min) versus vessel speed (mph) which will insure even distribution of the alum and sodium aluminate. Suitable in-line pressure gauges and flowmeters to measure chemical delivery rates will also be used.

The treatment vessel will be equipped with 2 translucent polyethylene tanks with a combined capacity of up to 1,500 gallons. These tanks are also graduated on the outside, which allows our operators to visually monitor chemical delivery to insure the desired volumetric ratio is met.

Since the two chemicals cannot be tank-mixed prior to application, there are two separate pumping systems for each product including individual spray lines and drop-hoses. The chemical delivery spray boom will be mounted on the stern of the boat where the drop-hoses will emit the chemicals into the propwash of the outboard motor. Dispersing the chemicals into the propwash promotes flash mixing of the two products and ultimately excellent floc formation. Through our extensive prior alum/aluminate treatment experience, we have found that the use of this arrangement and application methodology provides the best results.

The treatment will be guided with an on-board GPS (CASE EX-Guide 250 guidance system). The guidance systems will show the pond and treatment area and treatment sector boundaries. The system logs the path of the treatment vessel. Each load of chemical will be logged and monitored.

The 9 g/m^2 treatment will entail the application of approximately 17,000 gallons of aluminum sulfate and 8,500 gallons of sodium aluminate. The treatment will require 3-4 days to complete.

MONITORING PROGRAM

The table below outlines the components of the monitoring program and the goals of each. Details are provided in the following sections.

Table 1: Monitoring Program Design

Monitoring Component	Timing in relation to treatment	Location(s)	Goal
Water quality	Before, during, and after each application	3 established locations within each treatment zone	Evaluate short and long-term effects on water quality
Monitoring of state-listed species	Upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cell/ml), one year following completion of alum treatments and 5-years after completion of alum treatments	5 paired plots	Evaluate short and long-term effects on these species identified by NHESP as potentially susceptible to the treatment

Water Quality Monitoring

The water quality monitoring plan for West Monponsett Pond will include sampling at a single location within each of the three treatment zones. Sampling collection will occur immediately prior to each treatment and several days following each treatment. In addition to the sample collection, basic *in situ* testing will be performed throughout each alum application.

Each pre and post-treatment water quality sample will be analyzed for the following parameters.

- pH
- Alkalinity
- Total Phosphorus
- Dissolved Phosphorus

The *in situ* testing that will be performed during treatment will include the following.

- Secchi depth
- Dissolved oxygen
- pH
- Alkalinity

Monitoring of State-Listed Mussel Species

Long-term Mussel Monitoring Program

Since the submission of the original 'Habitat Management Plan' in May 2012, the pre-treatment and one year following the initial 2013 alum treatment long-term mussel monitoring event have been performed. Minor modifications to the proposed long-term mussel monitoring provided in the original 'Habitat Management Plan' were made by the NHESP-approved biologist performing these surveys. Monitoring was also conducted in 2015, but was abbreviated in extent due to poor and potentially toxic conditions. In order to maintain comparability with past mussel monitoring events, the modified survey methodology (below) will be implemented on 3 occasions, 1) upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cells/ml), 2) one year following completion of alum treatments and 3) 5 years after completion of alum treatments. This methodology was provided to the NHESP by Biodrawversity in a report titled, "Monitoring the Effects of Low-Dose Alum Treatment on *Leptodea ochracea*, *L. nasuta*, and *Neurocordulia obsolete* in the Western Basin of Monponsett Pond (Halifax, Massachusetts)" and the relevant excerpt is copied below. Per conversations with the NHESP in 2015, additional revisions to this methodology is indicated below in **bold** text.

> *The basic sampling unit [will be] a 1 x 1 meter ($1m^2$) quadrat bounded by a frame, with two centerlines that [divide] the quadrat into four 0.5 x 0.5 meter sections. The centerlines facilitated more careful searching in the low-visibility environment. Quadrat locations [will be] marked with underwater markers and recorded with GPS to enable the precise area of each to be resurveyed. Five quadrats [will be] established at 10 sites (50 quadrats total); the 10 sites [will be] paired (one shallow, one deep) at five locations in the pond (Figure 1). The quadrats [will be] arranged in a consistent pattern at each site (Figure 2). For each quadrat, biologists [will] first [conduct] a visual and tactile search to count the number of mussels (all species) occurring at or near the surface. The biologists then [will excavate] and [sieve] sediment from within one-fourth ($0.25m^2$) of the quadrat area to find buried mussels. Surface counts and buried counts [will be] recorded for each species, and shell length* ***and shell condition*** *[will be] recorded for L. ochracea and L. nasuta. Once these two steps [are] completed, all mussels [will be] placed back within the confines of the each quadrat. The following habitat information [will be] recorded for each quadrat: water depth, spatial extent of each substrate type, and percent cover of macrophytes. During the two post-treatment surveys, biologists [will] also [count]* ***and note shell condition of*** *freshly dead shells in addition to the steps described above.*

Figure 1 & 2. Mussel and Dragonfly monitoring stations (**Figure 1**) and quadrat arrange (**Figure 2**) derived from Biodrawversity's 2014 report, "Monitoring the Effects of Low-Dose Alum Treatment *Leptodea ochracea*, *Ligumia nasuta*, and *Neurocordulia obsolete* in Monponsett Pond.

Figure 1. Locations of mussel monitoring sites (Sites 1-5, including shallow and deep plots at each site) and dragonfly survey sites (E-1, E-2, and W-1 to W-7) in West and East Monponsett Pond in Halifax, MA.

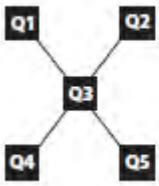


Figure 2. Spatial array of 5 1.0 m² quadrats (Q) at each site. Bricks were left on the lake bottom at Q1, Q2, Q4, and Q5; these were connected by strings and the intersection of the two strings marked the location of Q3. These were easily installed in 2013 and found again in 2014.

Monitoring of State-Listed Dragonfly Species

Long-term Dragonfly Monitoring Program

As stated above, since the submission of the original 'Habitat Management Plan' in May 2012, the pre- treatment and one year following the initial 2013 alum treatment long-term dragon-fly monitoring event have been performed. Minor modifications to the proposed long-term mussel monitoring were made by the NHESP-approved biologist performing these surveys. In order to maintain comparability with past events, the modified survey methodology will be implemented on 3 occasions, 1) upon reaching suitable conditions (phosphorus levels <20 pbb and sustained cyanobacteria counts <50,000 cells/ml), 2) one year following completion of alum treatments and 3) 5 years after completion of alum treatments.. This methodology was provided to the NHESP in a report titled, "Monitoring the Effects of Low-Dose Alum Treatment on *Leptodea ochracea*, *L. nasuta*, and *Neurocordulia obsolete* in the Western Basin of Monponsett Pond (Halifax, Massachusetts)" and the relevant excerpt is copied below. No additional revisions were requested during previous conversations with the NHESP.

> *Dragonfly surveys, focusing on N. obsoleta … [is scheduled to be completed in 2018]. Survey timing… [will]… accommodate weather conditions during the emergence period to ensure that surveys [are] conducted under the best possible conditions. Qualitative surveys of larvae, exuviae, and tenerals [will be conducted] using a combination of aquatic D-net sweeps in or near aquatic vegetation and other submerged structure,*

snorkeling in shallow water to hand-pick larvae, and walking along the shoreline to look for exuviae and tenerals on the lakeshore (especially rocks, bridge abutments, and trees). The causeway between the West and East basins [will be] surveyed most intensively, but several other locations in West and East Monponsett Pond [will] also [be] assessed and surveyed (Figure 1[see above]). Specimens [will be] collected, preserved in alcohol, and identified under a dissecting microscope.

Monitoring of Fish and Wildlife Response to Treatment

As in previous years, *in situ* in-water and shoreline monitoring will investigate any potential mortality of fish and other wildlife as a consequence of the buffered alum treatment. During the buffered alum treatment, *in situ* in-water and shoreline monitoring for fish and/or other wildlife mortalities will be conducted by the treatment/monitoring team. *In situ* in-water and shoreline monitoring will proceed as follows:

- **Treatment team**

    - Licensed applicator and assistant(s) will actively monitor the immediate treatment area for fish and/or wildlife mortality during application

- **Treatment/Monitoring Team**

    - Inspections of the treatment areas will be conducted in conjunction with *in situ* water testing

    - Twice daily (before and after daily treatment) visual inspection of pond's perimeter for fish and/or wildlife mortality will be performed.

Any deceased fish and/or wildlife encountered during *in situ* in-water monitoring will be documented. Documentation will include: written observations regarding the counts (by species), time observed, and photographs of each specimen. All information pertaining to a fish and/or wildlife kill event will be immediately provided to the Division of Fisheries and Wildlife—Southeast (DFW-SE).

REPORTING

During any year that treatment and/or monitoring is performed, the NHESP will be provided with a year-end report. The report will include documentation of any alum treatments performed (i.e., treatment dates and amounts of products applied) and associated monitoring (i.e., pre, in situ, and post-treatment water quality monitoring, and *in situ* monitoring of fish and wildlife in all years, as well as mussel monitoring. The year-end report will also discuss the treatment program's on-going efficacy any conclusion regarding effects of the treatment program to the state-listed species and their habitat.

Appendix B

Treatment Monitoring Program at the West Basin of Monponsett Pond Raw Data (Table 1-2)

Table 1. Monthly water quality sampling results

Date	Site ID	TP (ppb)	DP (ppb)	TAlk (mg/L)	Turbidity (NTU)	DO (mg/L)	Avg. Secchi (ft.)
5/14/18	A	28	17	x	x	x	7.7
	B	21	10	9.6	x	6.72	
	C	22	13	x	x	x	
6/28/18	A	16	10	x	0.95	x	X
	B	16	10	10	1.1	7.72	
	C	14	10	x	0.80	x	
7/11/18	A	14	10	x	1.3	x	10.5
	B	11	16	10.4	0.82	7.44	
	C	12	16	x	0.70	x	
8/6/18	A	21	13	x	2.8	x	4.6
	B	22	10	11.9	2.8	6.56	
	C	23	10	x	2.9	x	
10/19/19	A	10	10	x	0.95	x	7
	B	10	10	9	1.3	9.96	
	C	10	10	x	1.3	x	

x – No data collected

Table 2. *In-situ* water quality sampling results

Date	Site ID	pH (surface)	Avg. Alk (mg/L)	Avg. Secchi (ft)
5/14/18	A	6.67	x	7.0
	B	6.81		
	C	6.72		
5/15/18	A	7.0	x	6.76
	B	6.80		
	C	6.72		
5/17/18	A	6.85	x	7.3
	B	7.04		
	C	6.87		
5/18/18	A	6.85	x	7.3
	B	6.71		
	C	6.69		
	B			
	C			

Deliverables:
Task 2. Approved Order of Conditions

Subject: Monponsett Ponds - Order of Conditions, DEP File # SE 171-0412 - Halifax
From: ACT Info <info@aquaticcontroltech.com>
Date: 4/7/2015 12:58 PM
To: "kkelly@town.halifax.ma.us" <kkelly@town.halifax.ma.us>

Dear Ms. Kelly,

Aquatic Control (formally Lycott Environmental) is contacting you on behalf of our client, the Town of Halifax. The purpose of our letter is to request written acknowledgement from the Halifax Conservation Commission regarding the Monponsett Ponds Order of Conditions DEP File # SE 171-0412.

Information obtained from MassDEP's website regarding an update to the Permit Extension Act, (Sections 74 and 75 of Chapter 238 of the Acts of 2012, the Acts) indicate the Monponsett Ponds Order of Conditions will now be valid until June 19, 2019.

Please find attached a Memorandum to be signed and returned Aquatic Control (faxed or scanned email copies are acceptable). Thank you for your assistance. If you have any questions or need additional information, please feel free to contact us.

Sincerely,
Sarah Morin
Aquatic Control Technology, LLC
21 West Main Street Spencer, MA 01562
Tel: 508-885-0101 / Fax: 774-745-0277
email: info@aquaticcontroltech.com
website: www.aquaticcontroltech.com

Attachments:

MonponsettPd_Halifax.15 PEA ext.pdf	218 KB
MonponsettPd_Halifax.15 PEA Memo.pdf	114 KB

Gave to Charlie 4/13/15

Halifax Conservation Commission
< Letterhead >

MEMORANDUM
for:
Monponsett Ponds
Order of Conditions, DEP File # SE 171-0412

APPLICANT
Town of Halifax
c/o Mr. Charles Seelig

The Order of Conditions for Monponsett Ponds qualifies under the extended Massachusetts Permit Extension Acts (the Acts) for a four-year extension. The Acts grants an automatic four-year extension to any approval or permit that was 'in effect or existence' during the period beginning on August 15, 2008, and extending through August 15, 2012, beyond its otherwise applicable expiration date.

No action needs to be taken to extend this permit as the expiration date is automatically valid until June 19, 2019.

Signed: _____

Date: 4-7-15

For the -
Town of Halifax
Conservation Commission
499 Plymouth Street
Halifax, MA 02338

AQUATIC CONTROL TECHNOLOGY

April 7, 2015

Town of Halifax
Conservation Commission
499 Plymouth Street
Halifax, MA 02338
kkelly@town.halifax.ma.us

Via Email

RE: Monponsett Ponds – Halifax, Massachusetts
Order of Conditions, DEP File # SE 171-0412

Dear Halifax Commission Members:

Lycott Environmental now operating under the Aquatic Control Technology brand, is contacting you on behalf of our client, the Town of Halifax c/o Mr. Charles Seelig. The purpose of our letter is to request written acknowledgement from the Halifax Conservation Commission regarding the Monponsett Ponds Order of Conditions, DEP File Number SE 171-0412, having an expiration date of June 19, 2015 as it relates to the Governor's 2010 and 2012 Permit Extension Act. The Acts, as written, extends regulatory approval for an additional automatic four-year extension to an Order of Conditions 'in effect or existence' between August 15, 2008 and August 15, 2012.

We understand the four-year extension authorized by the Acts is automatic and that no action needs to be taken to implement an extension. However, when obtaining a BRP WM 4 - License to Apply from MassDEP for Dean Pond, Aquatic Control provides written acknowledgement from the Halifax Conservation Commission of the Acts' effect extending the current Order.

Since no action needs to be taken to implement the four-year extension, we ask that the Commission confirm the updated expiration date for Monponsett Ponds Order of Conditions, DEP File # SE 171-0412 to June 19, 2019, based on the Acts of 2010 and 2012, by providing an authorized signature on the enclosed Memorandum. The signed Memorandum from the Commission will be attached to the existing Amended Order of Conditions in our records and a copy will be sent to Mr. Charles Seelig.

Please return the signed Memorandum to Aquatic Control at your earliest convenience. Thank you for your assistance. If you have any questions, please feel free to contact us.

Sincerely,

Sarah M. Morin

Sarah Morin

Cc: Mr. Charles Seelig – Town of Halifax, Town Administrator

MonponsettPds_Halifax15.ext

TOWN OF HALIFAX

Office of the CONSERVATION COMMISSION
499 Plymouth St., Halifax MA 02338
781-293-1735 781-294-7684 fax

June 20, 2012

Town of Halifax
Charlie Seelig, Town Administrator
499 Plymouth Street
Halifax, MA 02338

Dear Mr. Seelig,

Enclosed please find a copy of the Order of Conditions for Alum Treatments to be conducted at the Eastern and Western basins of Monponsett Pond in Halifax, Massachusetts. The original recording will be kept on file in this office. If you have any questions, please feel free to call me. Thank you.

Sincerely,

Michelle Hill
Conservation Commission Secretary

Enclosure

CC: DEP
NHESP
Lycott Environmental, Inc.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

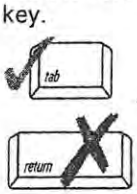
WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number: SE 171-0412

A. General Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



From: Halifax
1. Conservation Commission

2. This issuance is for (check one): a. ☒ Order of Conditions b. ☐ Amended Order of Conditions

3. To: Applicant:

Charlie (a. First Name) | Seelig (b. Last Name) | Town of Halifax - Board of Selectmen (c. Company)
499 Plymouth Street (d. Mailing Address)
Halifax (e. City/Town) | MA (f. State) | 02338 (g. Zip Code)

4. Property Owner (if different from applicant):

Commonwealth of Mass. | (Great Pond) (b. Last Name) | Department of Conservation and Recreation (DCR)
251 Causeway Street, Suite 600 (d. Mailing Address)
Boston (e. City/Town) | MA (f. State) | 02114-2104 (g. Zip Code)

5. Project Location:

Monponsett Ponds (eastern & western basin) (a. Street Address) | Halifax/Hanson (b. City/Town)
(c. Assessors Map/Plat Number) | (d. Parcel/Lot Number)
Latitude and Longitude, if known (**note:** electronic filers will click for GIS locator): 042.0059971 N (e. Latitude) | 070.8470054 W (f. Longitude)

6. Property recorded at the Registry of Deeds for (attach additional information if more than one parcel):

Plymouth (a. County) | (b. Certificate (if registered land))
(c. Book) | (d. Page)

7. Dates: November 23, 2009 (a. Date Notice of Intent Filed) | June 19, 2012 (b. Date Public Hearing Closed) | June 20, 2012 (c. Date of Issuance)

8. Final Approved Plans and Other Documents (attach additional plan or document references as needed):

Alum Treatments in East & West Monponsett Ponds (a. Plan Title)
Lycott Environmental, Inc. (b. Prepared By) | Lee Lyman (c. Signed and Stamped by)
(d. Final Revision Date) | (e. Scale)
Additional Information for Application to Condut Low-Dose Aluminum Sulfate Treatment - West Basin of Monponsett Pond | 11/22/2010 (g. Date)

B. Findings

1. Findings pursuant to the Massachusetts Wetlands Protection Act:

Following the review of the above-referenced Notice of Intent and based on the information provided in this application and presented at the public hearing, this Commission finds that the areas in which work is proposed is significant to the following interests of the Wetlands Protection Act. Check all that apply:

a. ☒ Public Water Supply
b. ☒ Land Containing Shellfish
c. ☒ Prevention of Pollution
d. ☐ Private Water Supply
e. ☒ Fisheries
f. ☒ Protection of Wildlife Habitat
g. ☐ Groundwater Supply
h. ☒ Storm Damage Prevention
i. ☒ Flood Control

2. This Commission hereby finds the project, as proposed, is: (check one of the following boxes)

Approved subject to:

a. ☒ the following conditions which are necessary in accordance with the performance standards set forth in the wetlands regulations. This Commission orders that all work shall be performed in accordance with the Notice of Intent referenced above, the following General Conditions, and any other special conditions attached to this Order. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, these conditions shall control.

Denied because:

b. ☐ the proposed work cannot be conditioned to meet the performance standards set forth in the wetland regulations. Therefore, work on this project may not go forward unless and until a new Notice of Intent is submitted which provides measures which are adequate to protect these interests, and a final Order of Conditions is issued. **A description of the performance standards which the proposed work cannot meet is attached to this Order.**

c. ☐ the information submitted by the applicant is not sufficient to describe the site, the work, or the effect of the work on the interests identified in the Wetlands Protection Act. Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides sufficient information and includes measures which are adequate to protect the Act's interests, and a final Order of Conditions is issued. **A description of the specific information which is lacking and why it is necessary is attached to this Order as per 310 CMR 10.05(6)(c).**

Inland Resource Area Impacts: Check all that apply below. (For Approvals Only)

3. ☒ Buffer Zone Impacts: Shortest distance between limit of project disturbance and wetland boundary (if available) — 0 a. linear feet

Resource Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
4. ☐ Bank	a. linear feet	b. linear feet	c. linear feet	d. linear feet
5. ☐ Bordering Vegetated Wetland	a. square feet	b. square feet	c. square feet	d. square feet
6. ☒ Land Under Waterbodies and Waterways	528 acres a. square feet 0 e. cu.yd dredged	b. square feet f. cu.yd dredged	0 c. square feet	d. square feet

B. Findings (cont.)

Resource Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
7. ☐ Bordering Land Subject to Flooding	a. square feet	b. square feet	c. square feet	d. square feet
Cubic Feet Flood Storage	e. cubic feet	f. cubic feet	g. cubic feet	h. cubic feet
8. ☐ Isolated Land Subject to Flooding	a. square feet	b. square feet		
Cubic Feet Flood Storage	c. cubic feet	d. cubic feet	e. cubic feet	f. cubic feet
9. ☐ Riverfront area	a. total sq. feet	b. total sq. feet		
Sq ft within 100 ft	c. square feet	d. square feet	e. square feet	f. square feet
Sq ft between 100-200 ft	g. square feet	h. square feet	i. square feet	j. square feet

Coastal Resource Area Impacts: Check all that apply below. (For Approvals Only)

10. ☐ Designated Port Areas	Indicate size under Land Under the Ocean, below			
11. ☐ Land Under the Ocean	a. square feet	b. square feet		
	c. cu.yd dredged	d. cu.yd dredged		
12. ☐ Barrier Beaches	Indicate size under Coastal Beaches and/or Coastal Dunes below			
13. ☐ Coastal Beaches	a. square feet	b. square feet	c. c/y nourishmt.	d. c/y nourishmt.
14. ☐ Coastal Dunes	a. square feet	b. square feet	c. c/y nourishmt.	d. c/y nourishmt
15. ☐ Coastal Banks	a. linear feet	b. linear feet		
16. ☐ Rocky Intertidal Shores	a. square feet	b. square feet		
17. ☐ Salt Marshes	a. square feet	b. square feet	c. square feet	d. square feet
18. ☐ Land Under Salt Ponds	a. square feet	b. square feet		
	c. cu.yd dredged	d. cu.yd dredged		
19. ☐ Land Containing Shellfish	a. square feet	b. square feet	c. square feet	d. square feet
20. ☐ Fish Runs	Indicate size under Coastal Banks, inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above			
	a. cu.yd dredged	b. cu.yd dredged		
21. ☐ Land Subject to Coastal Storm Flowage	a. square feet	b. square feet		

C. General Conditions Under Massachusetts Wetlands Protection Act

(only applicable to approved projects)

1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this Order.

2. The Order does not grant any property rights or any exclusive privileges; it does not authorize any injury to private property or invasion of private rights.

3. This Order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, bylaws, or regulations.

4. The work authorized hereunder shall be completed within three years from the date of this Order unless either of the following apply:
   a. the work is a maintenance dredging project as provided for in the Act; or
   b. the time for completion has been extended to a specified date more than three years, but less than five years, from the date of issuance. If this Order is intended to be valid for more than three years, the extension date and the special circumstances warranting the extended time period are set forth as a special condition in this Order.

5. This Order may be extended by the issuing authority for one or more periods of up to three years each upon application to the issuing authority at least 30 days prior to the expiration date of the Order.

6. Any fill used in connection with this project shall be clean fill. Any fill shall contain no trash, refuse, rubbish, or debris, including but not limited to lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles, or parts of any of the foregoing.

7. This Order is not final until all administrative appeal periods from this Order have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed.

8. No work shall be undertaken until the Order has become final and then has been recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the proposed work is to be done. In the case of the registered land, the Final Order shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the proposed work is done. The recording information shall be submitted to this Conservation Commission on the form at the end of this Order, which form must be stamped by the Registry of Deeds, prior to the commencement of work.

9. A sign shall be displayed at the site not less then two square feet or more than three square feet in size bearing the words,

"Massachusetts Department of Environmental Protection" [or, "MA DEP"]

"File Number 171-0412"

C. General Conditions Under Massachusetts Wetlands Protection Act

10. Where the Department of Environmental Protection is requested to issue a Superseding Order, the Conservation Commission shall be a party to all agency proceedings and hearings before DEP.

11. Upon completion of the work described herein, the applicant shall submit a Request for Certificate of Compliance (WPA Form 8A) to the Conservation Commission.

12. The work shall conform to the plans and special conditions referenced in this order.

13. Any change to the plans identified in Condition #12 above shall require the applicant to inquire of the Conservation Commission in writing whether the change is significant enough to require the filing of a new Notice of Intent.

14. The Agent or members of the Conservation Commission and the Department of Environmental Protection shall have the right to enter and inspect the area subject to this Order at reasonable hours to evaluate compliance with the conditions stated in this Order, and may require the submittal of any data deemed necessary by the Conservation Commission or Department for that evaluation.

15. This Order of Conditions shall apply to any successor in interest or successor in control of the property subject to this Order and to any contractor or other person performing work conditioned by this Order.

16. Prior to the start of work, and if the project involves work adjacent to a Bordering Vegetated Wetland, the boundary of the wetland in the vicinity of the proposed work area shall be marked by wooden stakes or flagging. Once in place, the wetland boundary markers shall be maintained until a Certificate of Compliance has been issued by the Conservation Commission.

17. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify the Conservation Commission, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by this Order.

18. All work associated with this Order is required to comply with the Massachusetts Stormwater Policy Standards.

Special Conditions:

If you need more space for additional conditions, select box to attach a text document ☒

see attached per NHESP

D. Findings Under Municipal Wetlands Bylaw or Ordinance

1. Is a municipal wetlands bylaw or ordinance applicable? ☒ Yes ☐ No
2. The Halifax Conservation Commission hereby finds (check one that applies):
3. ☐ that the proposed work cannot be conditioned to meet the standards set forth in a municipal ordinance or bylaw specifically:

a. Municipal Ordinance or Bylaw _____ b. Citation _____

Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides measures which are adequate to meet these standards, and a final Order of Conditions is issued.

4. ☐ that the following additional conditions are necessary to comply with a municipal ordinance or bylaw:

a. Municipal Ordinance or Bylaw _____ b. Citation _____

The Commission orders that all work shall be performed in accordance with the following conditions and with the Notice of Intent referenced above. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, the conditions shall control.

If you need more space for additional conditions, select box to attach a text document ☒

c. The special conditions relating to municipal ordinance or bylaw are as follows:

E. Issuance

This Order is valid for three years, unless otherwise specified as a special condition pursuant to General Conditions #4, from the date of issuance.

June 19, 2012
1. Date of Issuance

Please indicate the number of members who will sign this form:

3
2. Number of Signers

This Order must be signed by a majority of the Conservation Commission.

The Order must be mailed by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the appropriate Department of Environmental Protection Regional Office, if not filing electronically, and the property owner, if different from applicant.

Signatures:

Notary Acknowledgement

Commonwealth of Massachusetts County of Plymouth

On this 19 (Day) of June (Month) 2012 (Year)

Before me, the undersigned Notary Public, personally appeared Tina Tonello (Name of Document Signer)

proved to me through satisfactory evidence of identification, which was/were personally known (Description of evidence of identification)

to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he/she signed it voluntarily for its stated purpose.

As member of Halifax (City/Town) Conservation Commission

MICHELLE B. HILL
Notary Public
COMMONWEALTH OF MASSACHUSETTS
My Commission Expires
June 3, 2016

Signature of Notary Public

Michelle B. Hill
Printed Name of Notary Public

June 3, 2016
My Commission Expires (Date)

Place notary seal and/or any stamp above

This Order is issued to the applicant as follows:

☐ by hand delivery on

Date

☒ by certified mail, return receipt requested, on June 20, 2012
Date

F. Appeals

The applicant, the owner, any person aggrieved by this Order, any owner of land abutting the land subject to this Order, or any ten residents of the city or town in which such land is located, are hereby notified of their right to request the appropriate DEP Regional Office to issue a Superseding Order of Conditions. The request must be made by certified mail or hand delivery to the Department, with the appropriate filing fee and a completed Request of Departmental Action Fee Transmittal Form, as provided in 310 CMR 10.03(7) within ten business days from the date of issuance of this Order. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant. Any appellants seeking to appeal the Department's Superseding Order associated with this appeal will be required to demonstrate prior participation in the review of this project. Previous participation in the permit proceeding means the submission of written information to the Conservation Commission prior to the close of the public hearing, requesting a Superseding Order or Determination, or providing written information to the Department prior to issuance of a Superseding Order or Determination.

The request shall state clearly and concisely the objections to the Order which is being appealed and how the Order does not contribute to the protection of the interests identified in the Massachusetts Wetlands Protection Act, (M.G.L. c. 131, § 40) and is inconsistent with the wetlands regulations (310 CMR 10.00). To the extent that the Order is based on a municipal ordinance or bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

Section G, Recording Information is available on the following page.

G. Recording Information

This Order of Conditions must be recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land subject to the Order. In the case of registered land, this Order shall also be noted on the Land Court Certificate of Title of the owner of the land subject to the Order of Conditions. The recording information on Page 7 of this form shall be submitted to the Conservation Commission listed below.

Detach on dotted line, have stamped by the Registry of Deeds and submit to the Conservation Commission.

To:

Halifax
Conservation Commission

Please be advised that the Order of Conditions for the Project at:

Monponsett Ponds (eastern & western basin) — Project Location
SE 171-0412 — DEP File Number

Has been recorded at the Registry of Deeds of:

County | Book | Page

for:

Property Owner

and has been noted in the chain of title of the affected property in:

Book | Page

In accordance with the Order of Conditions issued on:

Date

If recorded land, the instrument number identifying this transaction is:

Instrument Number

If registered land, the document number identifying this transaction is:

Document Number

Signature of Applicant

Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond

Applicant: Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Representative: Lycott Environmental, Inc.
21 West Main Street
Spencer, MA 01562

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Dragonfly Cursory Survey and Potential Monitoring Locations
Mussel Monitoring Stations
Sample Locations for Chemical and Physical Assessment

Schedule

NHESP APPROVAL PAGE

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

June 6, 2012

Town of Halifax
499 Plymouth Street
Halifax, MA 02338

Conservation Commission
Town of Halifax
499 Plymouth Street
Halifax, MA 02338

RE: Applicant: Town of Halifax
Project Location: Monponsett Pond, Western Basin
Project Description: 1 year of phosphorus inactivation (alum) in the western basin in areas deeper than 4 feet (~235 acres).
NHESP Tracking No.: 09-27490

To Whom It May Concern:

Thank you for submitting the *Notice of Intent* for the proposed project including the final written plan for phosphorus inactivation, entitled "Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond" (dated 5/17/12, the "Management Plan"), to the Natural Heritage & Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries & Wildlife, in compliance with the rare wildlife species section of the MA Wetlands Protection Act Regulations (310 CMR 10.59). We additionally received supporting documentation for review pursuant to the MA Endangered Species Act (MESA) (MGL c131A) and its implementing regulations (321 CMR 10.00).

Based on our review of the information submitted and the information that is contained in our database, the NHESP has determined that the proposed project will occur within mapped habitat of the following state-listed species: Tidewater Mucket (*Leptodea ochracea*, mussel), Eastern Pondmussel (*Ligumia nasuta*, mussel) and the Umber Shadowdragon (*Neurocordulia obsolete*, dragonfly). These species are state-listed as "Special Concern"and individuals and their habitats are protected in accordance with the MESA.

Wetlands Protection Act (WPA)
For projects within *Estimated Habitat*, the WPA Regulations state that "...if a proposed project is found by the issuing authority to alter a resource area which is part of the habitat of a state-listed species, such project shall not be permitted to have any short or long term adverse effects on the habitat of the local population of that species" (310 CMR 10.37, 10.59), and that "no project may be permitted within the riverfront area which will have any adverse effect on specified habitat sites of rare wetland or upland, vertebrate or invertebrate species, ... or which will have any adverse effect on vernal pool habitat certified prior to the filing of the Notice of Intent" (310 CMR 10.58(4)(b)).

Based on a review of the information that was provided and the information that is currently contained in our database, the NHESP has determined that this project, as currently proposed, will not adversely affect the

Division of Fisheries and Wildlife
Field Headquarters, One Rabbit Hill Road, Westborough, MA 01581 (508) 389-6300 Fax (508) 389-7890
An Agency of the Department of Fish and Game

LYCOTT

actual Resource Area Habitat of state-protected rare wildlife species provided all work is conducted in accordance with the Management Plan.

MA Endangered Species Act

The MA Division of Fisheries and Wildlife's Natural Heritage and Endangered Species Program (the "NHESP") reviewed this project pursuant to the habitat management exemption, 321 CMR 10.14 (15), of the MESA which states, "[t]he active management of State-listed Species habitat, including but not limited to mowing, cutting, burning, or pruning of vegetation, or removing exotic or invasive species, for the purpose of maintaining or enhancing the habitat for the benefit of rare species, provided that the management is carried out in accordance with a habitat management plan approved in writing by the Division [of Fisheries & Wildlife]."

The NHESP hereby approves the proposed management activity, specifically the 1 year phosphorus inactivation activities within the western basin of Monponsett Pond, pursuant to 321 CMR 10.14(15) provided the following conditions are met:

1. Work must be conducted in accordance with the submitted Management Plan.
2. Mussel monitoring must be completed in accordance with the "Monitoring of State-Listed Mussel Species" section of the Management Plan and if impacts are observed on state-listed mussels, then the contingency plan, shall also be developed in accordance with the Management Plan. The qualified mussel-biologist shall submit for and receive a MESA Commercial Scientific Collection Permit to be in possession of state-listed mussels.
3. The Applicant shall provide the NHESP and the MA DFW Southeast District Office forty-eight (48) hours advanced, written notification of commencement of work.
4. If a "take" of state-listed species occurs, the Applicant may be required to file for a 'after-the-fact' Conservation & Management Permit pursuant to 321 CMR 10.23 and meet the performance standards to achieve a Long-term Net Benefit.

The NHESP does not, and cannot, authorize entrance onto private lands. Permission must be acquired by the landowner of record. This authorization does not permit actions not specifically described in the above noted Management Plan. Any changes to the proposed activities or any additional work beyond that described in the approved management plan may require a filing with the NHESP pursuant to the revised MESA regulations. This determination addresses only the matter of state-listed species and their habitats.

Please contact Misty-Anne R. Marold, Endangered Species Review Biologist, at (508) 389-6356 (misty-anne.marold@state.ma.us) to address any questions or comments you may have about this letter.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director

cc: Halifax Conservation Commission
MA DEP, Southeastern Regional Office, Wetlands
Jason Zimmer, District Supervisor, MA DFW-Southeast Wildlife District
(Jason.zimmer@state.ma.us; steve.hurley@state.ma.us)

LYCOTT

Habitat Management Plan for Phosphorus Inactivation in the West Basin of Monponsett Pond Halifax/Hanson, Massachusetts 2012

BACKGROUND

Monponsett Pond, located in the towns of Halifax and Hanson, Massachusetts, is a significant ecological, historical, and recreational resource as well as an important supplementary water supply for the nearby City of Brockton. The 528-acre pond is bisected by Route 58 which splits the water body into two basins - east and west - directly connected only by a small culvert in the southern portion of the pond. Both basins are highly developed with residential homes and receive inputs from a suburban watershed of approximately 6 mi^2.

As a whole, Monponsett Pond has been heavily impacted by use of its waters and watershed, and both basins have been placed on the Massachusetts Integrated List of Waters (303(d) list). As of 2010, the eastern basin was categorized as a 4c water body for presence of exotic species and a Total Maximum Daily Load (TMDL) was published in 2007 for high concentrations of mercury. The western basin appears on the 2010 303(d) list as a category 5 water body for nutrients, noxious aquatic plants, turbidity, and exotic species. The presence of two exotic aquatic vegetation species; Fanwort (*Cabomba caroliniana*) and Variable Milfoil (*Myriophyllum heterophyllum*), have been recorded recently in the eastern basin, while presence of Fanwort was noted in the western basin.

Both basins have also been subject to algae blooms in the past several years; however, the western basin has undergone extensive algae blooms for the past 25 years. During the summers of 2010 and 2011 these blooms prompted the closure of the western basin to swimming and boating for much of the summer. Algae testing has been carried out both by the Massachusetts Department of Public Health (MA DPH) and Massachusetts Department of Environmental Protection (MA DEP) throughout the summer months. MA DPH also conducted analysis of water quality, including total phosphorus. These results show a definite association between concentration of total phosphorus and total cell count in the western basin throughout the summer.

Despite these water quality challenges, the western basin has been identified as an area of priority habitat by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Review Program (NHESP). The presence of the following three state-listed species of special concern has been confirmed as recently as June 2011: Tidewater Mucket (*Leptodea ochracea*), Eastern Pondmussel (*Ligumia nasuta*), and Umber Shadowdragon (*Neurocordulia obsoleta*).

PHOSPHORUS REDUCTION GOALS FOR THE MONPONSETT WATERSHED

The Town of Halifax is working towards developing a Watershed Management Plan for the Monponsett Ponds. Since the large watershed lies not only within Halifax, but also Hanson and Pembroke, coordination between each municipality and the land owners within the watershed is of the upmost importance. The following is an outline of goals developed by Halifax Town Officials:

1. Work with the newly established Monponsett Pond Watershed Association (organized by the Halifax Board of Health with a first meeting of March 15, 2012)
2. Start a monitoring program to determine phosphorus levels

3. Work to determine sources and amounts from the following:
    a. Storm sewers
    b. Septic systems
    c. Run-off from cranberry bogs and other upstream sources
    d. Fertilizer use around the ponds
4. Develop a filtering system for storm water management
5. Continue to monitor septic system use around the Ponds and work with property owners to repair and replace systems
6. Work with cranberry bog owners to utilize Best Management Practices and reduce phosphorus loads in the bogs
7. Encourage use of non-phosphorus fertilizers for lawn/plant care around the ponds

PROPOSED PHOSPHORUS INACTIVATION PROGRAM

The on-going effort to improve water quality in Monponsett Pond and thereby its ability to support aquatic life, recreation, aesthetics, and use as a water supply has recently focused on reduction of phosphorus in the western basin. A phosphorus inactivation program has been proposed including the use of aluminum as a flocculant. The presence of three state-listed species of special concern has prompted NHESP to require analysis of the reaction of these species and monitoring of water quality before, during, and after the proposed treatment. The following sections of this treatment and monitoring plan provide details on the development of the treatment and monitoring activities that will take place as a result.

PERMITTING

Several layers of permitting – federal, state, and local – exist for the management program proposed for the western basin of Monponsett Pond. The permitting requirements are described here in progressive order.

❖ Orders of Conditions

The Halifax and Hanson Conservation Commissions have issued Orders of Conditions OOCs), DEP File #s_____ and _____ respectively. These OOCs are valid for __ years or until ___ and ___. Copies are attached to this document.

❖ Massachusetts Endangered Species Act

Both basins of Monponsett Pond have been designated by the Massachusetts Division of Fisheries and Wildlife (DF&W) Natural Heritage and Endangered Species Review Program (NHESP) as Priority Habitat for Rare Species and Estimated Habitat for Rare Wildlife. The proposed project occurs within the mapped habitat of the following state-listed species:

Scientific Name	Common Name	Taxonomic Group	MA Status
Leptodea ochracea	Tidewater Mucket	Freshwater Mussel	Special Concern
Ligumia nasuta	Eastern Pondmussel	Freshwater Mussel	Special Concern
Neurocordulia obsolete	Umber Shadowdragon	Dragonfly	Special Concern

Based on the goal of the project to restore the western basin as an ecologically functional water body it will be evaluated as 'management of State-listed Species habitat' per 321 CMR 10.14

Exemptions from Review for Projects or Activities in Priority Habitat in accordance with the following:

> *The following Projects and Activities shall be exempt from the requirements of 321 CMR 10.18 through 10.23: 15. the active management of State-listed Species habitat, including but not limited to mowing, cutting, burning, or pruning of vegetation, or removing exotic or invasive species, for the purpose of maintaining or enhancing the habitat for the benefit of rare species, provided that the management is carried out in accordance with a habitat management plan approved in writing by the Division...*

This document serves as the habitat management plan and has been approved by DF&W as described above (NHESP Approval Page, page 2).

- **U.S. EPA National Pollution Discharge Elimination System Permit**

  In accordance with the U.S. Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NPDES) permit, a Notice of Intent (NOI) of Coverage Under the Pesticide General Permit (PGP) for Discharges from the Application of Pesticides will be filed prior to the treatment of the western basin of Monposnett Pond. This permit is expected to be valid for five (5) years.

- **Massachusetts License to Apply Chemicals**

  A 'License to Apply Chemicals' will be obtained from the Massachusetts Department of Environmental Protection, Office of Watershed Management for each year a treatment is conducted.

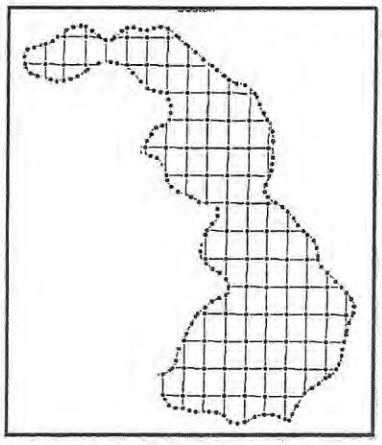
TREATMENT DESIGN

Although referred to as a 'whole-lake' treatment, the aluminum sulfate and sodium aluminate will be applied to areas of the lake that are deeper than four (4) feet - a total of approximately 235 acres, or 83% of the basin. Treatment of areas less than four feet in depth is not considered advantageous in large water bodies due to the disruption of this shallow area by wind and wave action.

Based on jar testing, an in-water aluminum concentration of 3 ppm is anticipated to remove a large percentage of phosphorus from the water column. Typically, aluminum is added to the water column through an aqueous application of aluminum sulfate ($Al_2(SO_4)_3$) . Data collected from the western basin indicates that the water body has poor buffering capacity (alkalinity has been estimated at 11.5 mg/L $CaCO_3$) and therefore simultaneous application of sodium aluminate is recommended. An aluminum sulfate to sodium aluminate ratio of 2:1 represents the theoretical balance point for pH in poorly buffered lakes such as Monponsett Pond, and therefore, the planned dose for treatment of the western basin of Monponsett Pond is 12,732.56 gallons of aluminum sulfate and 6,366.28 gallons of sodium aluminate.

In order to reduce the potential impact on fauna present within the pond and to accommodate application logistics, the 235-acre treatment area will be broken into sections which will further be divided into 2.77-acre sectors. Each day of treatment will focus upon one of the sections with each sector within that section treated in a pattern such that no two connecting sectors receive treatment sequentially. Each of these sectors will be treated with 150 gallons of aluminum sulfate and 75 gallons of sodium aluminate - the capacity of the treatment vessel. It is anticipated that alum application will last approximately thirty minutes and application of the entire treatment area will span a one-week period.

Liquid aluminum sulfate and sodium aluminate will be applied to the lake surface simultaneously from a moving treatment vessel. The boat's operator will follow a pre-established path through each sector by carefully monitoring the boat's position via a hand-held GPS unit. The boat's path and speed will be recorded with the same GPS unit for future analysis.



Example of GPS tracks used for guidance during treatment

MONITORING PROGRAM

The table below outlines the components of the monitoring program and the goals of each. Details are provided in the following sections.

Table 1: Monitoring Program Design

Monitoring Component	Timing in relation to treatment	Location(s)	Goal
Large-scale jar test	2 weeks prior	Treatment staging area	Verify that pH in the treatment area will remain within the target range of 6.5 and 7.5
Water quality	Before, during, and after months and years following	10 established locations; multiple locations during treatment	Evaluate short and long-term effects on water quality
Measurement of flocculation	During	1 visual recording; 6 measurement locations	Assess the amount of floc accumulated on the sediments
Monitoring of state-listed species	Before, during, and after One and five years following	5 paired plots	Evaluate short and long-term effects on these species identified by NHESP as potentially susceptible to the treatment
Sediment cores	Before and after One month, one and five years following	3 established locations	Assess changes in |AL| and sediment P

Chemical and Physical Assessment of Treatment

Jar Test

A large-scale jar test will be conducted at the treatment staging area approximately 14 days prior to the scheduled treatment to verify that pH in the treatment area will remain between 6.5 and 7.5 at present water quality conditions. Water will be transferred directly from the subject water body to a 55 gallon glass tank and allowed to settle. Analysis of pH and alkalinity will be conducted and the planned concentration of aluminum will be added, with the planned ratio of aluminum sulfate to sodium aluminate, and applied to the collected water. Alkalinity and pH will be assessed one hour following treatment and again the following morning.

If results of this jar test indicate that pH will fall outside of the 6.5 to 7.5 range, the application rate and ratio will be reassessed and adjusted if necessary. An additional jar test will be carried out as described above to confirm that the adjustments produce the desired results. The treatment will not proceed until the application rate is confirmed to have limited effect on pH.

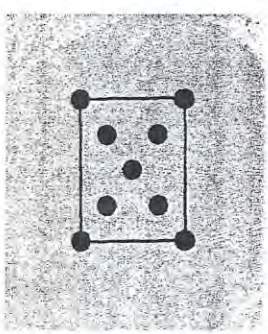
Water Quality Monitoring

The water quality monitoring plan for Monponsett Pond will include sampling at a total of ten (10) locations (see map of **Sample Locations for Chemical and Physical Assessment**). These locations have been selected based on their varying depths and proximity to the treatment area – both inside and out.

The following parameters will be evaluated at each of the 10 sampling locations twice daily on days that treatment takes place. Samples will be collected in the morning before treatment begins and in the evening when treatment has ended for the day.

- Secchi depth
- Dissolved oxygen
- Conductivity
- Total Phosphorus (three locations, mornings following treatment)
- Temperature
- pH
- Alkalinity

Analysis of pH and alkalinity will be conducted *in situ* on an hourly basis. Sampling will occur within the area that was treated one hour previous to the sample collection to allow for stabilization of water conditions and settling of alum through the water column. Following each hour of treatment, 9 locations within the area that has just been treated will be sampled for pH, dissolved oxygen, and alkalinity (see image at right). GPS locations of each sample point will also be recorded with a Garmin GPSMAP 60CSx as samples are taken. Observations of the treatment procedures, floc formation, and any fish and wildlife interactions will be made throughout the treatment and recorded along with all water quality data in a weatherproof field notebook.



Approximate location of sample locations within treatment sectors

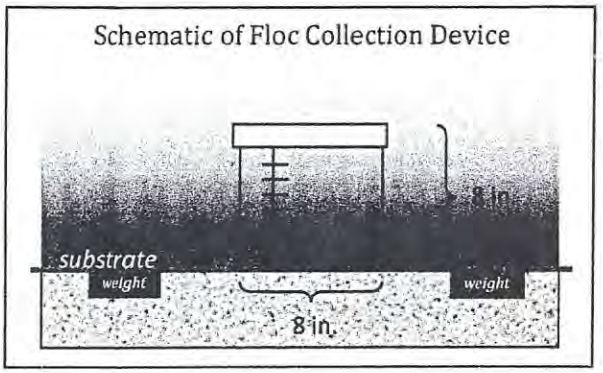
If pH consistently falls outside of the 6.5 to 7.5 range during these sampling events, the results will be verified with duplicate samples. If pH outside of the prescribed range persists, treatment will be suspended. Additional monitoring will be conducted and NHESP/DEP will be contacted to determine when the treatment may resume.

A sampling program for the parameters listed above will continue in the months and years following the

initial treatment in conjunction with additional treatments and/or state-listed species monitoring.

Measurement of Flocculation

In order to measure the amount of flocculation occurring during the treatment, six pairs of floc-collection devices will be installed prior to the treatment. These devices will be designed to capture floc as it precipitates to the pond's bottom. Five of the six measurement stations will be situated in close proximity to the paired plots that will be monitored for state-listed mussels (state-listed species section below), while the sixth will be placed at the pond's deep hole. Two graduated (in inches) floc-collection devices will be installed on weighted pieces of plywood or similar material that will be placed on the substrate. The depth of floc in each device will be measured by an underwater observer the morning following treatment of the section in which it is located and all devices will be measured the morning following the last day of treatment. Images of the devices and floc will be recorded during each observation period.



In an effort to observe flocculation as it occurs, an underwater video camera will be set up in a shallow treatment location where water clarity will allow visual observation. A floc-collection device will be installed at this location so that measurement of floc may be conducted as well.

It should be noted that the western basin of Monponsett Pond is generally extremely turbid with secchi depths of less than one foot common throughout the summer and fall. Clarity may therefore inhibit this visual observation. Should low clarity persist during treatment, rendering the underwater recording of floc depth impossible, floc-collection devices will be covered with a water-tight lid and brought to the surface by a diver. The device will be transported to shore where it will be allowed to settle for measurement.

Sediment Sampling

Three locations have been selected for sediment core sampling to assess changes in aluminum and phosphorus concentrations (see map of **Sample Locations for Chemical and Physical Assessment**). Samples will be collected utilizing an AMS 2" x 4' Soft Sediment Core Sampler with samples collected in an acrylic Plexiglas tube.

Site	Location relative to treatment area	Water depth (ft.)
5	Outside	1
9	Inside	5
1	Inside	10

Sediment cores will be collected from these locations one day prior to treatment and one month following the completion of treatment. Additional cores will be collected one and five years following

treatment in conjunction with state-listed species monitoring.

Monitoring of State-Listed Mussel Species

Several monitoring procedures will be conducted prior to, during, and following the initial buffered low-dose alum treatment of the western basin of Monponsett Pond. These monitoring events will allow for an assessment of the mussel populations, including the two state-listed species, in the pond and their reaction to the treatment. Based on the limited visibility present in the western basin of Monponsett Pond, monitoring procedures have been developed such that the lack of visual contact does not inhibit the production of valid results.

Long-term Mussel Monitoring Program: Pre- and Post-Treatment Mussel Monitoring

The monitoring conducted prior to the buffered low-dose alum treatment will be a repeatable event using semi-quantitative methods to investigate the abundances, catch-per-unit-effort, demographics (*i.e.,* size structure), shell conditions, distributions, and habitat of the mussel species in the western basin of Monponsett Pond. Comparison of the baseline survey with follow-up surveys (*i.e.* one and five years following the first treatment) will allow for assessment of the long-term effects of a buffered low-dose alum treatment on individual mussel populations in the west basin of Monponsett Pond.

A total of five-paired plots will be surveyed to gather baseline information on the mussel species in the western basin. In order to reduce sampling costs, plot locations will be situated in areas with known mussel beds (see map for **Mussel Monitoring Stations**) (GZA Environmental, 2011). At each site, two 25-m^2 quadrats will be established; one quadrat will be situated in shallow water (1-4 feet) while the other will be placed in deeper water (>4 feet). The precise location of each plot will be recorded using a hand-held GPS device. Additionally, the boundary of each plot will be delineated by installing markers (concrete bricks painted with Sea Hawk Smart Solution Metal Free Bottom Paint) at two-foot intervals directly outside the sampling frame. Due to the characteristic poor visibility in the western basin, sampling bias will be an obvious concern at the time of the survey. Sampling bias will be accounted for by implementing a modified 25-m^2 quadrat. The modified sampling apparatus will be rectangular (12.5 x 2 m in size) and equipped with a center guideline.

At each quadrat, a diver will employ visual and tactile search methods to collect mussels within the sampling frame. Searches will initiate from a random start point (*i.e.,* either end of the sampling frame) and will continue for 30 minutes. In addition to gathering mussels, the diver will record three habitat features, percent substrate composition, percent cover of rooted aquatic macrophytes, and depth (ft.). Water visibility, time spent for visual versus tactile search methods, and proportion of quadrat sampled at stoppage time will also be measured to account for inter-observer variability. In scenarios where searches are completed prior to the 30-minute stop time; the diver will also take note of amount of time needed to search the entire quadrat.

Upon search completion, gathered mussels will be placed into a mesh bag. The mesh bag will be attached to a surveying vessel by a rope and a series of tugs will alert a topside observer to surface the gathered mussels for examination. Once surfaced, gathered mussels will be identified to the species-level, counted, and measured for shell length (anterior-posterior dimension across the valves to the nearest 0.1 mm). The topside observer will also assess the degree of shell erosion according to the following rank system:

Rank	Erosion Type
0	no erosion
1	erosion limited to the umbo
2	erosion of the umbo and partial erosion of valves
3	complete or nearly complete erosion of both umbo and valves

At this time, the diver will excavate 1% of the quadrat area. Excavations will involve the removal of all substrate from the 1% area to a depth of 10 to 15 cm, and transport of the material to a mesh bag where it can be examined at the surface. At the surface, excavated material will be sifted through a set of sieves (smallest size 4 mm) to detect smaller mussels. Again, all mussels discovered during this process will be identified, counted, and measured for length. Following measurements, a representative individual from each species collected will be documented by photograph. All substrate and mussels will be returned to their original location in filtering position. Simultaneously, the diver will utilize fluorescently painted washers tied to a surface float to designate locations with high abundances of state-listed species within the long-term monitoring station. This process will help facilitate site selection for *in situ* mussel monitoring (as detailed below). Markers will be removed during the follow-up long-term monitoring survey.

In situ Mussel Monitoring: Behavioral Responses of Mussels to a Buffered Low-Dose Alum Treatment

The *in situ* monitoring program aims to investigate mussel behavioral responses of two-state listed species, Tidewater Mucket (*Leptodea ochracea*) and Eastern Pondmussel (*Ligumia nasuta*), to a buffered low-dose alum treatment in the western basin of Monponsett Pond.

A total of five locations will be selected for *in situ* monitoring of state-listed mussel species, Tidewater Mucket and Eastern Pondmussel. In order to reduce sampling costs, *in situ* monitoring will be performed within the long-term monitoring stations (*i.e.*, five-paired plots; refer to map for **Mussel Monitoring Stations**). *In situ* monitoring site locations will be selected based upon two criteria:

- At depths >4 ft. deep to correspond with the treatment area
- At locations with known presence of the two state-listed mussel species

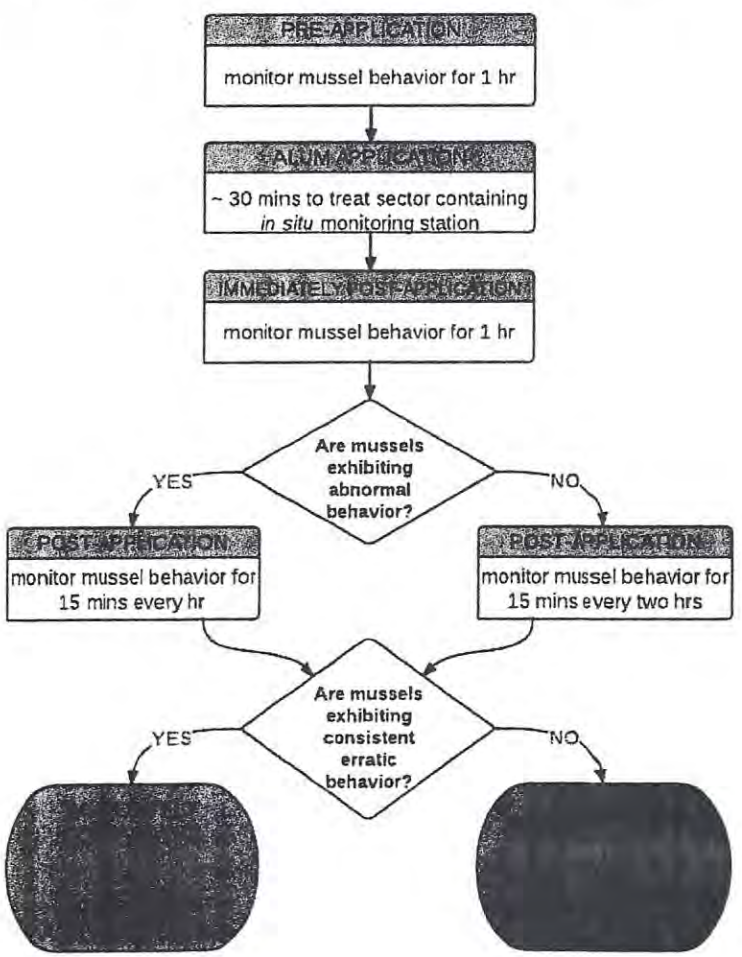
The five *in situ* monitoring locations are intended to assess mussel behavioral responses during the entire buffered low-dose alum treatment. As previously mentioned in the **treatment design**, it is anticipated that total treatment duration will span one work week or five days. Prior to application, the five individual (treatment) sectors containing the *in situ* monitoring stations will be assigned to a separate section (*i.e.*, one day of treatment) so that behavioral responses of mussels may be observed during the entire treatment period. During application, the day's treatment activities will commence in the individual sector enclosing the *in situ* monitoring station.

One-hour prior to the first day of treatment, the observer will visit the corresponding *in situ* monitoring station included in the day's treatment activities. At this time, the observer will lower an underwater camera until mussels are within the monitor's view frame. At the surface, the underwater camera will be attached to a monitor and powered with a portable battery. The monitor and portable battery will be placed into a waterproof case and situated inside a buoy for easy accessibility. Mutual concession between the number of individuals within the view frame and adequate mussel behavior assessment will ultimately determine the underwater camera's distance from the pond's bottom. Once the appropriate adjustments have been made, the observer will record the number of mussels within the view frame.

Mussel behavior — pumping activity (active vs. inactive), valve activity (open vs. closed), positioning (upright vs. dislodged), foot activity (protracted vs. retracted) — will be qualitatively measured for a one hour period prior to the day's treatment activities. This information will be necessary to establish a baseline for natural mussel activity in the absence of an alum treatment (*i.e.*, control). Under optimal conditions, natural mussel activity is generally characterized by upright, prolonged active filtering interrupted by brief valve closures. Immediately following an application of the individual sector containing the *in situ* monitoring station, the observer will monitor mussel behavior for a one-hour time period (*i.e.*, treatment).

Mussel monitoring will proceed until one-hour following the day's treatment activities. Monitoring will be conducted utilizing the aforementioned methodology; however, monitoring duration will be limited to a 15 minute time period. Furthermore, sampling effort will be contingent on the mussel behavior observed during the one-hour treatment period. For instance, under a scenario in which signs of stress or mortality (*e.g.*, extended valve closure, dislodgement/disequilibrium, prolonged gaping with inactive filtering, and foot retraction) are detected, a higher sampling effort (15 min duration/per hr) will be performed for the remainder of the daily treatment activities. Conversely, less sampling effort (15 min duration/per two hrs) will be needed in the event that no adverse changes in mussel behavior are detected during the one-hour treatment period.

Upon monitoring completion, consistent erratic behavior (as detailed above) will be immediately reported to the NHESP, and future treatment activities will cease unless otherwise directed by the NHESP. However, if no significant changes are detected, the second day of treatment and *in situ* mussel monitoring will proceed in a similar manner as described above (and so on for treatments conducted on days 3 – 5). A schematic illustrating the *in situ* methodology is shown below:



Monitoring of State-Listed Dragonfly Species

Long-term Dragonfly Monitoring Program: Pre- and Post-Treatment Dragonfly Monitoring

A baseline survey will be designed as a repeatable event investigating the distribution, abundances and CPUE of the state-listed dragonfly species, *Neurocordulia obsoleta*. Comparing baseline survey information with follow-up surveys will allow for assessment of the long-term effects of a buffered low-dose alum treatment in west basin of Monponsett Pond on the aforementioned species.

A total of six plots (strip transects 105 m x 9 m in size) will be distributed in suitable habitat throughout the perimeter of the west basin of Monponsett Pond. Historically, *N. obsoleta* have been reported along the RT-58 causeway in the west basin of Monponsett Pond (GZA, 2011; personal communication the NHESP). As such, a higher sampling effort (four of the six plots) will be allotted to this particular portion of the water body. The remaining plots will be established in suitable habitat throughout the remainder of the west basin of Monponsett Pond. Determination of the exact location of these plots will be contingent on findings from a cursory survey of the perimeter of the west basin of Monponsett Pond. During the cursory survey, GPS coordinates (x, y), field notes, and photographs will document suitable habitat outside the RT-58 causeway area (see map for **Dragonfly Cursory Survey and Potential Monitoring Locations**).

At each plot, an observer will utilize an aquatic d-frame net (mesh size: 0.5 mm) to gather larval invertebrates within the sampling area. Searches will initiate from a random start point and will continue for 45 minutes. For the duration of the search, the observer will drag an aquatic net across the pond's bottom (to include ~2 cm depth) to gather larval invertebrates from key habitat features: substrate (≥ 32 mm in size), woody debris, and rooted vascular plants. Species within *Neurocordulia* are classified as 'climbers/clingers', and are generally not found within fine substrate. If necessary, the observer may incorporate hand-shoveling to facilitate the collection of bottom substrate and debris into the net. Periodically, the observer will carefully empty the net's contents into a 5-gallon holding bucket filled with nearby pond water.

It is likely that the baseline survey will be conducted prior to the *N. obsoleta's* emergence; *N. obsoleta* are generally on the wing from late-May to early-August. Therefore, it is anticipated that only *N. obsoleta* nymphs (*i.e.*, larval stage) will be present at the time of the baseline survey. If the baseline and followup surveys are conducted within the on the wing time period, survey methods will be carried out in a similar manner as detail above; however, following each 45 minute timed search an additional 15 minute timed search will be allotted to examine emergent features (*e.g.*, partially submerged substrate, emergent vegetation, and manmade structures) for *N. obsoleta* exuviae. Given the crepuscular nature of *N. obsoleta*, adults are not practical to observe in surveys conducted during the on the wing period.

Upon search completion, sample processing will be conducted on-shore nearby the sampling location. Gathered material will be transferred from the holding bucket(s) to a plastic dish tub for sorting. Using forceps, gathered invertebrates will be separated by family. *N. obsoleta* nymphs observed at this time will be counted. Accurate field identification of larvae is a difficult task; therefore, a subsample of *N. obsoleta* (n ≤ 5 *N. obsoleta* for all plots sampled per survey) will be preserved in a Whirl-Pak in 70% ethanol, labeled, and returned to the laboratory to verify field identifications. Surveys conducted during the 'on flight' period will also record the number of *N. obsoleta* exuviae collected during the 15 minute timed search. A subsample of *N. obsoleta* exuviae (n ≤ 15 *N. obsoleta* exuviae for all plots sampled per survey) will be preserved using the aforementioned methods, and returned to the laboratory to verify field identifications. Following sampling, removed material and invertebrates will be carefully returned to their original location.

Monitoring of Fish and Wildlife Response to Treatment

In situ in-water and shoreline monitoring will investigate mortality of fish and other wildlife as a consequence of the buffered low-dose alum treatment. During the buffered low-dose alum treatment, *in situ* in-water and shoreline monitoring for fish and/or other wildlife mortalities will be conducted by three parties: a treatment team, a survey team, and a shoreline observer. *In situ* in-water and shoreline monitoring will proceed as follows:

- **Treatment team**
  - Licensed applicator and assistant(s) will actively monitor the immediate treatment area for fish and/or wildlife mortality during application
- **Survey team**
  - Hourly follow-up inspections of the treatment areas will be conducted in conjunction with water quality testing and floc measurements
  - Quick (in-boat) visual inspection of pond's perimeter for fish and/or wildlife mortality following daily treatment activities
- **Shoreline observer**
  - Shoreline inspections (with binoculars) for fish and/or wildlife mortality from accessible lookout points; accessible lookout points will be evenly distributed throughout the pond's perimeter

Any deceased fish and/or wildlife encountered during *in situ* in-water and shoreline monitoring will be documented. Documentation will include: written observations regarding the counts (by species), time observed, and photographs of each specimen. All information pertaining to a fish and/or wildlife kill event will be immediately provided to the Division of Fisheries and Wildlife—Southeast (DFW-SE), and next-day treatment activities will cease unless otherwise directed by the DFW-SE. In a scenario where no fish and/or wildlife mortality is detected, the second day of treatment and *in situ* in-water and shoreline monitoring will proceed in a similar manner as described above (and so on for treatments conducted on days 3 – 5).

REPORTING

Several reports will be generated as a result of this Habitat Management Plan. These reports will be submitted to NHESP and other interested parties (*i.e.* the Client and Conservation Commissions).

<table>
<tr><th>Approximate Timing For Report Submission</th><th colspan="2">Description of Report and Information Contained Therein</th></tr>
<tr><td>Prior to treatment</td><td colspan="2">Results of the jar test and final treatment ratios, general information on treatment date and logistics</td></tr>
<tr><td rowspan="3">1 week following treatment</td><td colspan="2">General summary report on treatment activities including observations during treatment and raw data from sampling events</td></tr>
<tr><td colspan="2">A summary report of the results from the baseline mussel and dragonfly surveys. Results to be included:</td></tr>
<tr><td><u>Mussels</u>
➢ % rooted macrophytes, % substrate composition, species richness, abundance, CPUE, size structure, shell erosion
➢ Aforementioned variables reported per plot, per depth category (shallow/deep), and cumulatively (pond-wide)
➢ Descriptive statistics computed for qualitative data
➢ Size structure, abundance, and CPUE reported for each species
➢ Abundance and CPUE reported for the mussel community
➢ GIS-based map of precise locations of the mussel monitoring stations (i.e., five-paired plots)
➢ Copies of field notes, photographs, and the NHESP rare species data observation forms</td><td><u>Dragonfly</u>
➢ Abundance and CPUE for N. obsoleta
➢ Abundance and CPUE reported for each life stage
➢ All the aforementioned variables reported per plot and cumulatively (pond-wide)
➢ Descriptive statistics computed for qualitative data
➢ GIS-based maps of the precise locations of six plots and the additional suitable habitat locations
➢ Written description of the location and habitat features of the additional suitable habitat locations
➢ Copies of field notes, photographs, preserved specimens, and the NHESP rare species data observation forms</td></tr>
<tr><td>2-3 months following treatment</td><td colspan="2">Year-end report including data analysis for chemical and physical assessments before, during, and after treatment</td></tr>
<tr><td rowspan="2">1 year after treatment</td><td colspan="2">Final Report including all data collected for this Habitat Management Plan</td></tr>
<tr><td colspan="2">An in-depth report discussing the long-term effects of the treatment on the mussel populations and N. obsoleta in Monponsett Pond. Information to be included:
• Results of the baseline mussel and dragonfly surveys (as specified in '1-week following treatment')
• Results of the 1-year post-treatment mussel and dragonfly surveys (as specified in '1-week following treatment')
• Data analysis of the two datasets to detect changes from pre- to post-treatment</td></tr>
<tr><td>5 years after treatment</td><td colspan="2">Update the 1-year after treatment in-depth report discussing the long-term effects of the treatment on the mussel populations and N. obsoleta in Monponsett Pond. Information to be included:
• Results of the baseline mussel and dragonfly surveys (as specified in '1-week following treatment')
• Results of the 1-year post-treatment mussel and dragonfly surveys (as specified in '1-week following treatment')
• Results of the 5-year post-treatment mussel and dragonfly surveys (as specified in'1 week following treatment'
• Data analysis of the three datasets to detect changes from pre- to post-treatment</td></tr>
</table>

Sample Locations for Chemical and Physical Assessment

Legend

- Water Samples
- Sediment Cores, Water Samples

N

0 350 700 1,400

Feet

MassGIS Color Ortho Imagery

Monponsett Pond -Western Basin
Halifax & Hanson
Massachusetts

Lycott Environmental, Inc.

21 West Main Street
Spencer, MA 01562
508-885-0101
www.lycott.com
info@lycott.com

Mussel Monitoring Stations

Legend

- Individual (Mussel) Monitoring Station

N

0 500 1,000 1,500

Feet

1:11,000

Data Source(s):

MassGIS: USGS Topo Quad revised 01'

MassGIS: USGS Color Orthoimagery (30 cm) revised 08'-09'

Monponsett Pond
Halifax& Hanson
Massachusetts

Lycott Environmental, Inc.

21 West Main Street
Southbridge, MA 01562
508-885-0101
www.lycott.com
info@lycott.com

Dragonfly Cursory Survey and Potential Monitoring Locations

Legend

- Historical N. obsoleta Observations
- Cursory Survey

N

0 525 1,050 1,575

Feet

1:11,000

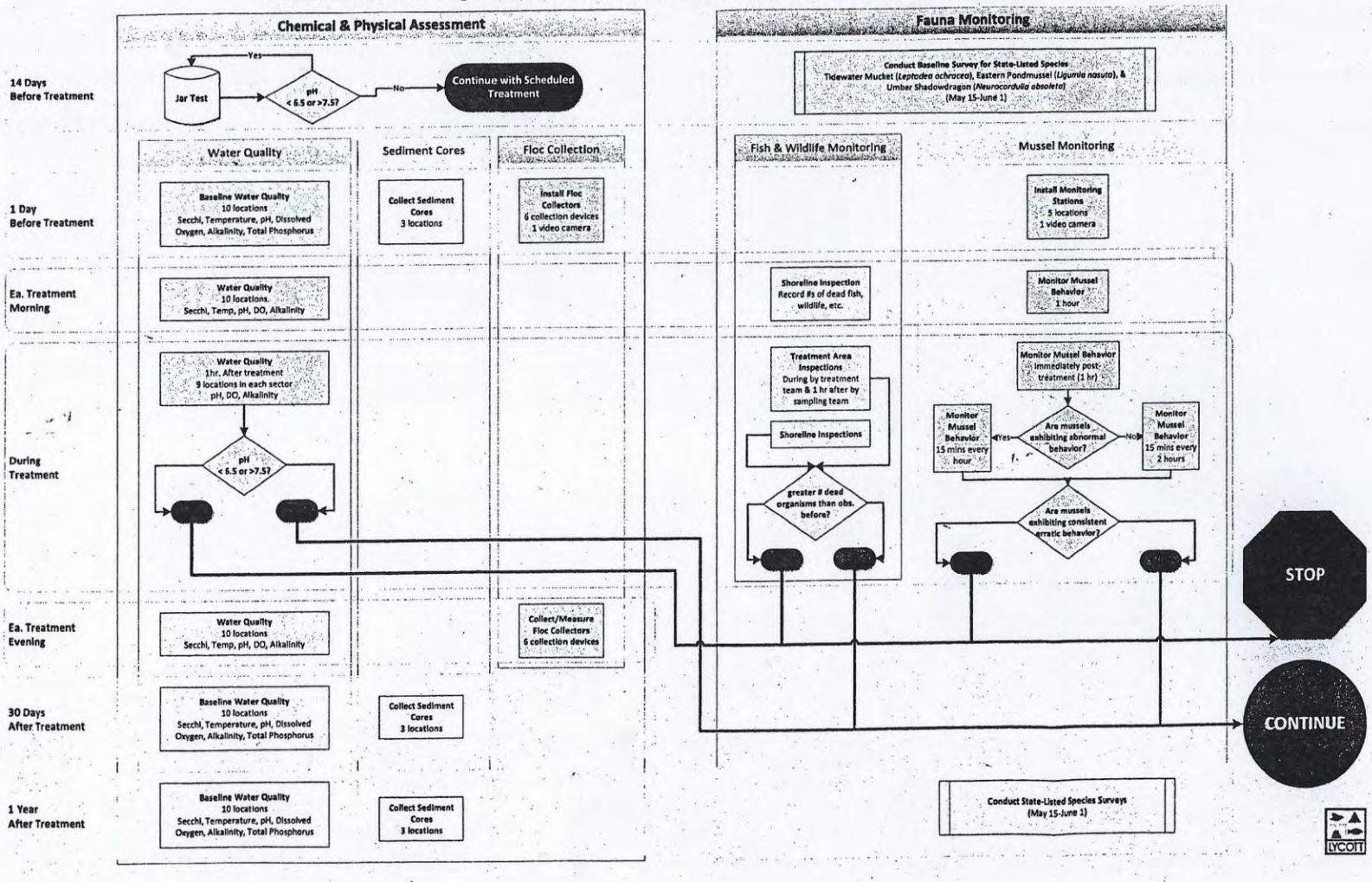
Data Source(s):

MassGIS: USGS Topo Quad revised 01'
MassGIS: USGS Color Orthoimagery (30 cm) revised 08'-09'

Monponsett Pond
Halifax/Hanson
Massachusetts

Lycott Environmental, Inc.
21 West Main Street
Spencer, MA 01562
508-885-0101
www.lycott.com
info@lycott.com

Schedule of Habitat Management Plan for Phosphorus Inactivation in the Western Basin of Monponsett Pond



MASSWILDLIFE

DIVISION OF
FISHERIES & WILDLIFE

1 Rabbit Hill Road, Westborough, MA 01581
p: (508) 389-6300 | f: (508) 389-7890
MASS.GOV/MASSWILDLIFE

Jack Buckley, *Director*

May 4, 2017

Charlie Seelig
499 Plymouth Street
Halifax, MA 02338

Ben Lynch
MA Department of Environmental Protection
251 Causeway Street, Suite 900
Boston, MA 02114-2104

RE:	Applicant:	Town of Halifax
	Project Location:	West Monponsett Pond
	Project Description:	Application of alum
	NHESP File No.:	**09-27490**

Dear Applicants:

The Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries & Wildlife (the Division) received a request for review pursuant to the MA Endangered Species Act Regulations (321 CMR 10.18) for the use of Alum in West Monponsett Pond.

Based on the information provided, input from the MA Department of Environmental Protection, and the information contained in our database, the Division finds that Phase 2 of this project, as currently proposed, **must be conditioned** in order to avoid a prohibited Take of state-listed species (321 CMR 10.18(2)(a)). To avoid a prohibited Take of state-listed species, the project shall comply with the following conditions:

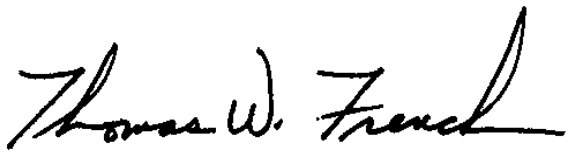
1. Areal Dose: 9.0-17.0 g/m^2 (2017)
2. Treatment Plan: The alum treatment plan will involve at least one large scale, early season application of 9.0 g/m^2 (~4 ppm Al). Depending on available resources, the dose may be increased up to 17.0 g/m^2 as a single or split-application treatment within the same calendar year.
3. Treatment Area: All areas of West Monponsett Pond deeper than four (4) feet for a total of about 235 acres; treated in three (3) sub-sections.
4. Monitoring Plan: The project will monitor water quality and state-listed species, as detailed in the 2017 HMP.
5. Authorization: This authorization is for the 2017 alum application in West Monponsett Pond and additional alum treatments in West Monponsett Pond approved in writing by the Division in 2018, 2019, 2020, and 2021.

6. Annual Report: At the completion of each treatment, an annual report shall be submitted to the Division as detailed in the HMP. The report shall additionally include the proposed treatment for subsequent years, if recommended.

Provided the above-noted condition is fully implemented and there are no changes to the project plans, this project will not result in a Take of state-listed species. We note that all work is subject to the anti-segmentation provisions (321 CMR 10.16) of the MESA. This determination is a final decision of the Division of Fisheries and Wildlife pursuant to 321 CMR 10.18. Any changes to the proposed project or any additional work beyond that shown on the site plans may require an additional filing with the Division pursuant to the MESA. This project may be subject to further review if no physical work is commenced within five years from the date of issuance of this determination, or if there is a change to the project. Upon filing for any renewal, extension, or amendment of the Orders of Conditions issued under the MA Wetlands Protection Act, the Applicant shall contact the Division to determine if re-filing under MESA is required.

Please do not hesitate to contact Misty-Anne R. Marold, Senior Endangered Species Review Biologist, at (508) 389-6356 (misty-anne.marold@state.ma.us) with any questions or comments you may have.

Sincerely,



Thomas W. French, Ph.D.
Assistant Director

cc: Dominic Meringolo, Solitude Lake Management

Attached: REVISED HABITAT MANAGEMENT PLAN FOR PHOSPHORUS INACTIVATION IN THE WESTERN BASIN OF MONPONSETT POND (2017)

Deliverables:
Task 9. Outreach and Education

T O W N OF H A L I F A X
COMMONWEALTH OF MASSACHUSETTS
Board of Health
499 Plymouth St., Halifax, MA 02338
Telephone (781) 293 6768 **Fax (781) 293 1738**
Health Agent: cdrinan@town.halifax.ma.us
Administrative Assistant: mselter@town.halifax.ma.us

319 Grant Halifax

Outreach and education

1. **Facebook** postings weekly on cyanobacteria counts

2. **"Science Shorts"** posted on Facebook (See attached)

3. **Radio interviews & panel discussions on WATD on Monday Night Talk with Kevin Tocci**

   January 29, 2018 6 to 8 pm, panel discussion on Watershed issues/concerns

   March 4, 2018 6 to 8 pm, panel discussion on Watershed issues/concerns

4. **Local public health columns** (numerous, see attached)

5. **Four sixth grade classes** attended for the health of the ponds and groundwater discussions and demonstrations.

Outreach & Education:
1. Facebook Postings

Halifax Board of Health shared a post.

Published by Cathleen Drinan · October 3, 2018 ·

Cathleen Drinan is feeling thankful.

October 3, 2018

Both ponds are Open

Cyanobacteria Counts - October 1, 2018

East Monponsett Pond, Holmes St beach: 8,242 cells per mL

***This is the second week in a row with the results below DPH's safety threshold of 70,000 cells/mL.

West Monponsett Pond, state boat ramp: 9,868 cells per mL

Halifax Board of Health

Published by Cathleen Drinan · October 19, 2018 ·

I haven't posted the pond results the last couple weeks. In case you are still following and wondering, here they are:

October 9, 2018: Both ponds OPEN

(70,000 cells/mL is the DPH threshold)

• East Monponsett, Holmes St beach ...

Halifax Board of Health

Like

Show more reactions

Comment

Cathleen Drinan

November 1, 2018

Last pond sampling for this year.

Both ponds are open.

On Monday, October 30, 2018, MassDEP collected water samples from East and West Monponsett Ponds.

• East Monponsett Pond: Rte. 36 beach: 526 cells/ml of cyanobacteria.

• West Monponsett Pond: State Boat Ramp contained 1,478 cells/ml of cyanobacteria.

These results are below the MDPH guideline level of 70,000 cells/ml.

We are thankful the Massachusetts Department of Environmental Protection took over the sampling and testing work once done by the Massachusetts Department of Public Health. That work began with grant funds by the Center for Disease Control in 2008. We now have a decade of data!

They are pretty ponds, aren't they? It is pretty important to take care of them!

Facebook post: Halifax Board of Health

Published by Cathleen Drinan · March 1 at 1:57 PM ·

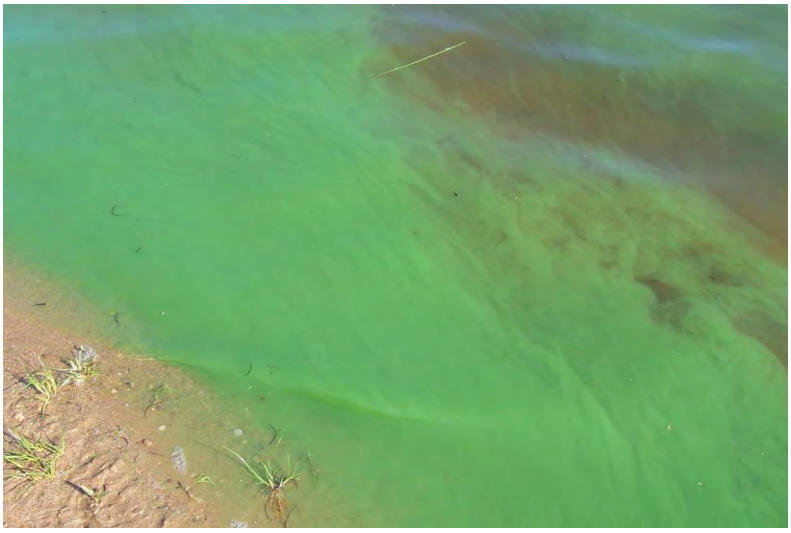
Halifax is wrapping up a 319 grant though the Department of Environmental Protection spanning more than a year.

The West Monponsett Pond Nutrient Management, Project # 17-05/319 worth $331,500, accomplished Alum treatments to the West Monponsett Pond. Alum binds with Phosphorous, making it unavailable as a nutrient for the cyanobacteria (blue green algae).

That treatment is the only factor I know of to account for the fact that the pond was open for recreation all summer for the first time in a decade! It went from green to clear! Residents and visitors had a great summer enjoying the improvement!

(242 People Reached) (66 Engagements) (1 Comment 4 Shares)

*** This was also shared to Halifax Locals and Halifax Local Community pages with hundreds of people liking it and commenting.




LYCOTT
ENVIRONMENTAL

March 1, 2019

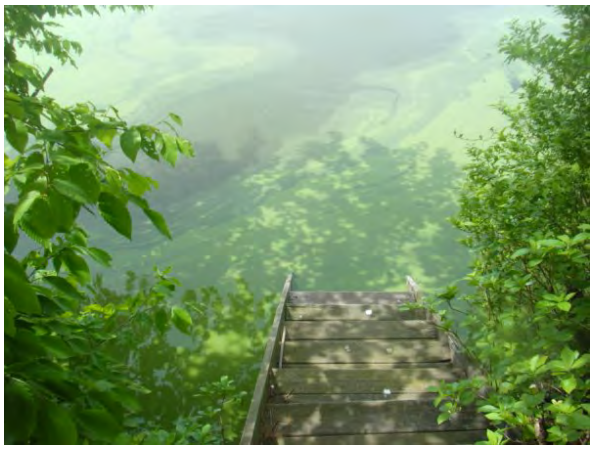
The following appeared on Facebook pages for Cathleen Drinan, Halifax Community, Halifax Locals and Halifax Board of Health.

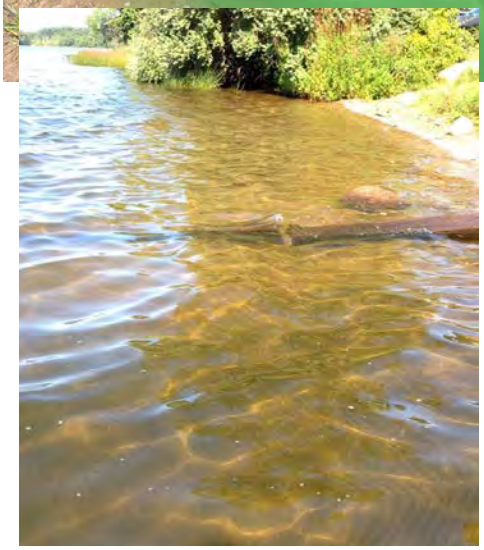
Halifax is wrapping up a 319 grant though the Department of Environmental Protection spanning more than a year.

The West Monponsett Pond Nutrient Management

Project # 17-05/319 worth $331,500, accomplished Alum treatments to the West Monponsett Pond. Alum binds with Phosphorous, making it unavailable as a nutrient for the cyanobacteria (blue green algae).

That treatment is the only factor I know of to account for the fact that the pond was open for recreation all summer for the first time in a decade! It went from green to clear! Residents and visitors had a great summer enjoying the improvement!





Outreach & Education:
2. Science Shorts

Science Shorts *by Cathleen Drinan*

Stormwater Sleuth

See that pretty pond in the background? It is the West Monponsett Pond. In Massachusetts, it is considered a Great Pond. And we want to keep it great!

The water in that pond is supposed to flow to the southwest, down Stump Brook. And it does sometimes. However, in 1964, it was decided that a dam could be built and that the water of both Monponsett Ponds could, from October to May, be diverted over to Silver Lake in Kingston.

That change made Silver Lake a Surface Water Supply and the Monponsett Ponds became Tributaries to a Surface Water Supply.

- Drinking water needs to be protected.
- We cannot live without water.

Whatever ends up in the street, arrives in the catch-basins, enters our stormwater system and then pollutes our once great ponds.

This trash was all inside one catch-basin in Halifax.

- ✓ Don't litter.
- ✓ Clean up after your dog.
- ✓ Don't allow chemicals to enter the street or catch-basin.
- ✓ Respect the earth.
- ✓ Keep our Great Ponds great!
- ✓ Stormwater Sleuths look for Stormwater Solutions!

Science Shorts *by Cathleen Drinan*

Creature Feature

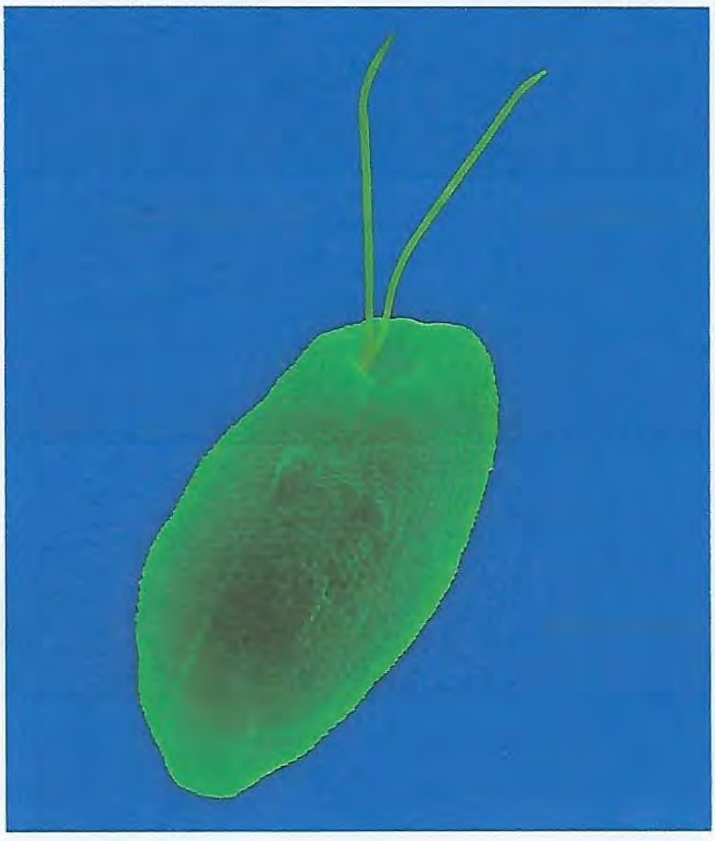
Scientists are curious and that is a good thing!

While looking for cyanobacteria in the Monponsett Ponds on October 22, 2018, the scientist noticed something else. He noted, "Very little to see. This week's sample was dominated by chrysophytes consisting of small unicellular flagellates of the genus Rhodomonas."

Chrysophytes are a type of algae. Each one is made up of only a single cell. (We have approximately 37.2 trillion cells in our body!)

The chrysophte might only have one cell but it still has parts; just as we are one body with parts such as eyes and ears, brain and stomach.

- This type has a tail and can move about! The scientists don't call them tails. They call them flagellum. They are a hair-like structure that can whip around, causing it to move.



- It also has a chloroplast so that it can photosynthesize, where the green pigment chlorophyll captures energy from sunlight and converting it to energy.
- This microscopic "creature" is not quite animal, but kind of plant-like, the way it can photosynthesize.
    - They produce almost one-half of the oxygen on the planet through photosynthesis!
    - They make up a huge part of the food chain.
    - Tiny as it is, that is an important creature!

Outreach & Education:

3. Radio Interview & Panel Discussion on WATD Monday Night Talk

The discussion of the West Pond and watershed issues were held on January 29, 2018 and March 4, 2018 – links to audio available upon request.

Outreach & Education:
4. Local Public Health Columns

The Great Collector and the Great Guidance System 4-7-17

The catch basins you see along the edge of the road are more than a convenient way to drain rain water off the road and, thus, prevent flooding and/or freezing of those floods. They can be considered the Great Collector of everything in the environment. Even pollutants from the air, both near and far, waft along until they settle to the earth. There, they are gathered by rain and are washed into the catch basins.

Even if you clean up after your dog, the residue is washed away and delivers E.coli, coliform, viruses and veterinary medicines into the catch basin.

When your yard receives a heavy rainfall, and that is more often than not the pattern now, fertilizers and herbicides are collected by run-off and delivered to the catch basins.

The cars we drive deliver not only us to our destinations, they deliver oil, fuel emissions, particulate matter, and a variety of chemicals considered to be carcinogens. Phosphorous is added to tires and bit by bit, it wears off, providing one of the main nutrients required by cyanobacteria to bloom and thrive in our local waterways. Where are these chemicals delivered? Initially, they are delivered to the road itself.

The pavement upon which we drive is the Great Guidance System leading to the Great Collector. The paved roads are impervious surfaces that have already gathered all the rain water from the other impervious surfaces, such as our roofs and driveways. All this rushing flowing water is filled during a heavy rain with whatever is in the total environment: air pollutants, building materials, chemicals, and organic compounds, a broad class of substances containing carbon and frequently containing nitrogen, sulfur, and phosphorus.

Now, you might think that the Great Collector has some way of managing or filtering these pollutants. Until we build differently and live differently, these catch basins were made a long time ago and they achieve their original purpose: they collect and move the water out of our way. I suspect that most of us are satisfied they do this job well and don't give it another thought.

Did you know that those catch basins lead directly to water bodies or wetlands? When they were built many decades ago, that made sense. Have water join the water. End of story.

But it is not the end of the story. We now understand that the Great Guidance System Delivers pollution to the Great Collector and the Great Collector delivers pollutants to the Great Network of Water Bodies and that Great Network drains to the Great Oceans.

And that is why the New England Interstate Water Pollution Control Commission (NEIWPCC) awarded $57,338 to Halifax to assist in engineering

efforts to help mitigate storm water impacts to East and West Monponsett Ponds! There are 40 outfalls (open pipes that discharge surface runoff during rain events) that contribute untreated storm water runoff to the ponds in Halifax.

The receiving ocean of our pollutants from Halifax is Narragansett Bay. That is why the Narragansett Bay Estuary Program was motivated to award these funds for our efforts. What we do in Halifax affects the quality of the lives and the environment in Rhode Island. According to the National Oceanic and Atmospheric Administration (NOAA), the largest contributor of pollution (80%) to the ocean is from the land. http://oceanservice.noaa.gov/facts/pollution.html. This is all pretty cool once you start connecting the dots, so to speak, for our waters are all connected.

The engineering work covered by the grant began with the mapping of the drainage pipes that make up all 40 outfalls. The area wis calculated for impervious cover leading to each outfall, such as pavement, roof tops, driveways, etc., and outfalls were prioritized by the largest contributing impervious area. This tells the Town of Halifax which outfalls to rehabilitate first by installing treatment mechanisms for phosphorus reduction. The grant also funded the conceptual design of all the outfalls, highlighting the three highest priority outfalls for a permit ready design. These designs can be used when applying for future grants that will help fund construction.

And we will need that assistance, for this work on the Great Collector will be expensive but it will be for the Greater Good.

6-30-17 Down by the Bay

While Russ Kleekamp and Craig Curtin were doing an excellent job last Thursday evening presenting to the Monponsett Watershed Association an overview of their serious stormwater assessment grant-funded work, I was thinking of a silly song.

My children used to say that it seemed I had a song for every occasion. I could not necessarily remember the whole song or even the name of the song but one line and the tune would come to mind and I would sing it.

As I listened to last week's presentation by the engineering firm, GHD, explain the stormwater assessment for Halifax, the song was "Down by the Bay", often sung by Raffi. The silly lyrics go like this:

Down by the bay
Where watermelons grow
Back to my home
I dare not go
For if I do
My mother will say
Did you ever see a baboon
Holding a balloon?
Down by the bay!

In my head, I was adding other silly lines about a crab and a horseshoe.
Did you ever see crab taking a cab?
Did you ever see a horseshoe looking kinda cuckoo?

You might think I am cuckoo also, but my family would have understood what I meant. You see, a couple weeks ago we were at Duxbury Beach and the bay side was loaded with horseshoe crabs. These primitive, (almost primordial at 500 million years), creatures are fascinating to watch, as their spiked tail leaves beautiful patterns in the sand. One stood out amongst its peers, though, for it was sporting a white tag about the size of a quarter. I took a ton of pictures that fun day and, of course, I took a picture of the tagged horseshoe crab.

When I examined the picture, I realized it had an 800 phone number I could call or I could go to the U.S. Fish and Wildlife website. There I read about the importance of the horseshoe crab. Its eggs provide an important food source for migrating birds and its blood is used by pharmaceutical companies to detect the presence of harmful bacteria, for their blue copper-based blood clots in the presence of bacteria!

After reporting the tag online, they were kind enough to respond. Here's what I found out about our Duxbury crab:

Tag number 20723 was released by Associates of Cape Cod, Inc. on 7/8/1999 at Warren, Narragansett Bay, RI.
Horseshoe Crab Database Manager
U.S. Fish and Wildlife Service
Maryland Fish and Wildlife Conservation Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401

This was so cool for me to learn because Halifax's Stormwater Assessment was funded by the New England Interstate Water Pollution Control Commission (NEIWPCC). The specific body of water being protected by this grant was the Narragansett Bay; the very same water from which this crab was released back in 1999!

Just allow that visual to sink in for a moment.

A little town twenty minutes inland from the Plymouth Bay receives $57,338 for engineering efforts to help mitigate stormwater impacts to East and West Monponsett Ponds.

Now imagine the 40 outfalls (open pipes that discharge surface runoff during rain events) contributing untreated stormwater runoff to the ponds in Halifax.

Zoom out a bit now and see where Halifax's water flows.

The receiving ocean of our pollutants from Halifax is Narragansett Bay.

What we do in Halifax affects the quality of the lives and the environment in Rhode Island. According to the National Oceanic and Atmospheric Administration (NOAA), the largest contributor of pollution (80%) to the ocean is from the land. http://oceanservice.noaa.gov/facts/pollution.html.

Now zoom out even more and see all the waters connected. One earth; one water.

Just as our pollutants hurt others; our improvements help others.

The engineering work by GHD of Hyannis, MA funded by the grant began with the mapping of the drainage pipes that make up all 40 outfalls. The area was calculated for impervious surfaces leading to each outfall, such as pavement, roof tops, driveways, etc., and outfalls were prioritized by the largest contributing impervious area. This tells the Town of Halifax which outfalls to rehabilitate/modify first by installing treatment mechanisms for phosphorus reduction. The grant also funded the conceptual design of all the outfalls, highlighting the three highest priority ones with a permit-ready design. These designs can be used when applying for future grants that will help fund construction.

And we will need that assistance, for this work to protect the ponds and the bays will be expensive but it will be for the greater good of all creatures great and small, even the primitive horseshoe crab, down by the bay.

Cathleen Drinan is the health agent for Halifax and Plympton. She can be reached at 781 293 6768 or cdrinan@town.halifax.ma.us

For more information on horseshoe crab tagging, see:

https://www.fws.gov/northeast/marylandfisheries/Fish%20Facts/horseshoe%20crab%20fact.html

7-7-17 Soft Rain

This year has brought some much needed rain, needed in more ways than we might appreciate. After some initial heavy downpours, I couldn't help but be satisfied with the gentle rain we finally received. Others may have wanted the rain to hold off for cookouts but I was grateful for the type of rain that fell.

This year's recent rains were something to celebrate because they were, as my father used to say "soft rain". He loved a soft rain because he loved to fish and the gentle rain would allow the worms to surface alive and still be used for bait. A heavy rain drowned them. That's a sad sight.

The other reason my father loved a gentle rain is because he loved his lawn. He had the best lawn in our little South Weymouth neighborhood. As kids on a boring summer day, riding our bikes around the neighborhood, looking for something to do and/or talk about, I once suggested that we choose the nicest looking yard. My friends quickly announced this was not fair because I knew very well that my yard would win that contest. So, okay, maybe they were right. I gave it a try on a boring day!

The reason that my father had the best lawn is the same reason why he loved a soft rain. When we received just a drizzle, he would look out the window with great satisfaction, announcing, "This will be great for weeding!" Shortly thereafter he could be found in his glory, in khakis and tee shirt, on his hands and knees, crawling around pulling out crabgrass and other unwanted arrivals. They pulled out easily because the earth was moist and soft at this point. He was a happy man on the day of a soft rain.

If my father was not able to get out there in the rain, (after all, he had eight children and was a full time professional pilot, in addition to carpenter, mechanic and inventor!), he still enjoyed watching it and appreciating it through the window. He might declare, "This is great! This is so needed! This soft rain will sink down into the earth. A heavy rain just creates a lot of run-off and flows into the catch basins. This rain is just right!"

My father's commentary on rain comes back to me now as an adult with him long gone (too long!) and I still learn from him. The Town of Halifax has a watershed association in response to the terrible problem of algae being responsible for closing beaches for most of the recent summers for the West Monponsett Pond. It is a widespread problem. It is a national problem. The algae requires nutrients and receives them from many sources, including agriculture, lawn fertilizers, failed septic systems sitting in the ground water and road run-off.

My father did not fertilize his lawn. That was not the thinking of the day. Compost maybe; manure, yes. My father did not apply herbicides either. It just wasn't the go-to solution of the time. His was truly the DIY generation and he and my mother did it themselves (DIT)! Weeds were eradicated by pulling; not by the application of poison.

I thought of my father recently during our episodes of soft rain. I went out to weed, just as my father had done so many decades before me. As I did, I began to experience other reasons why he loved a gentle rain and the activity of weeding. As I crawled around, I realized what a meditative and contemplative experience weeding can be. There were decisions to be made. Too much of this; too little of that. This is in the wrong place; better placed over there.

As I peeked under the low draping branches of a dwarf red maple, I discovered a seedling! Ah, a gift! I felt the wonder of a child and realized this is why most of the world's cave art was discovered by children. They look and then they see.

Then there were the metaphors galore! Did I get the whole root? Did I nip it in the bud? If uncertain, should I wait until "wheat and chaff" are evident? Thinking of the Bible while weeding is not a bad thing. These were truly enjoyable and relaxing questions to consider, outside of my personal sphere of problems and dilemmas and, thus, they took me away from those conflicts and did so better than any Calgon bath might!

They say the Bible was written by fishermen; maybe they did some weeding as well, to arrive at those universal insights! If we treat the earth as we want to be treated ourselves, with kindness and tenderness, we will be like that soft rain; sinking in, being effective and doing no harm along the way.

Cathleen Drinan is the health agent for Halifax and Plympton, MA. She can be contacted for questions and comments at 781 293 6768 or cdrinan@town.halifax.ma.us

Watersheds, Waterways, and the Wonders of Nature

In Halifax, we have an appreciation of the word “watershed” because of the intricacies of the politics and geography and our changed and changing environment. After a boat ride along the North River last weekend, I thought about the idea of appreciating waters from the land. Boy, do I have some places to explore being added to my current list!

Being a landlubber, it was fun to sit in a comfy pontoon boat and relax while listening to a docent-like tour of the North River. We learned about the great ship building era in the 1700 and 1800’s. Along the way we could see numerous plaques commemorating the ship yards of old. In 1919 the North River Historical Society formed, with its first mission being to document the shipyards before the knowledge of them disappeared. Some of them sounded familiar, such as Briggs and Brick Kiln, known to me as local family names and local streets, although I never knew the history behind them.

Among the many ships built there, two stood out as memorable. The brig, *Beaver,* was docked in Boston on December 16, 1773 and, yes, you guessed it; it’s load of tea was thrown into the harbor, now known as the Boston Tea Party.

The other ship mentioned on the tour was the *Columbia.* It weighed 200 tons and was the first American ship to carry the American flag around the world and the first of the “new world” people to explore the Columbia river, named to this day after a ship built on the North River!

The great gale of 1898 that changed the mouths of the North and South Rivers, bringing an end to the ship building era for the North River, which was perhaps fading anyway by then with a changing world and a depletion of the great forests.

It was difficult to visualize the forest depletion as we navigated along the winding river, for, after the beautiful marshes at the water’s edge, with a dock here and there leading to some beautiful homes, we mostly witnessed blocked views, blocked by thick forests. The first and perhaps the largest wooded area we passed was the hills of the Nelson Memorial Forest. I suspect it is one the hidden gems of the South Shore, as I am told the signage is not obvious from the street In Marshfield. This was the case for other trails and even a beach, the one and only on the river. In some places camping is allowed and we did, indeed, see evidence of nature lovers who had brought their tents and “bare necessities” by kayak and

canoe. These small vessels and tents provided the bits of color along the way of blue waters and green marsh grasses under the canopy of Saturday's stupendous blue sky filled with gorgeous cumulus clouds.

Many of these forested areas and trails are open to the public but not necessarily well known, especially how to access them. Some, such as North River Wildlife Sanctuary, serving as the base for South Shore Sanctuaries (including Daniel Webster and North Hill Marsh) are more easily accessed. Others may take some research through Audubon, the North and South River Watershed Association, and the Conservation Commissions in the connecting towns, for all these organizations own and protect much of the land along the North River.

And that was the biggest take-the away for me. People with foresight and determination to preserve nature and make it available for people to enjoy, had accomplished just that and it is there for us to do just that!

Another way to learn about these nature preserves is through the gift of documented walking experiences of John Galuzzo. I love listening to his *Walk of the Week* on WATD. One of his many books, *The North River: Scenic Waterway of the South Shore* is available on Amazon. He includes detailed directions and instructions for getting to these gems!

While there are twelve towns in the watershed, a handful touch the North River itself. We began at Rhot's Marine in Marshfield and traveled through Scituate, Norwell, Pembroke, and turned back at the bridge of the Southeast Expressway, long before the river reached Hanover and its final destination of Hanson. How many thousands of times have I traveled over that bridge, always admiring its beauty and yet, never ventured closer? Too many times; that is how many.

We were accompanied by a family of ospreys, graceful snowy egrets, a few seagulls, diving cormorants and swooping swallows and purple martins. We did not see the seals or the bald eagles. Maybe next time. I was thankful this place had been saved.

We need to stay strong and determined to save nature and our water in Halifax and the surrounding watersheds so that our ancestors can say the same of us.

Cathleen Drinan is the health agent for Halifax. She can be reached at 781293 6768 or cdrinan@town.halifax.ma.us

3-30-18 Sky to earth and back again

Sky to earth and back again, that's where water exists. It is an ever-moving cycle of precipitation, collection, absorption and evaporation, with a wide spectrum of other factors and influences tossed in, such as winds, soils, topography and plant life. During its visit to the earthly realm, it can deliver anything from salvation to destruction, depending on the amount, its speed and where you live.

Many areas in New England received more than their usual share of precipitation in the last month, causing cellars to be inundated with water, sump pumps to burn out, and even electrical systems and gas furnaces being shut down with rising water, leaving homeowners in a dangerous predicament and the local Fire Departments very busy. Lots of people are reading up on mold and mildew due to the recent rising of groundwater into their homes. There are countless families in the area who have never had to deal with wet basements, which are now facing losses in the thousands, in addition to the destruction of the downed trees.

I received some calls on the topic of ruined lower levels and constantly running sump pumps. They mostly wondered if the water problems had anything to do with recently repaired septic systems in their neighbor's yards. I sympathized as I listened to them. They had never seen water like this in all the years they had lived here. Their insurance companies were not covering the losses because they did not have flood insurance, yet, they did not live in flood areas. We could not help but wonder, was it really a flood?

It did not seem to be a flood in the typical sense of a water body, such as a river or pond or ocean, rising to such a level, that it spread into adjoining areas. What these homeowners had was melting snow and rainwater falling in such high amounts, for an extended period, in areas that could not drain fast enough to keep up with the falling water. It must go somewhere. And while it sits, it also seeps. It will follow the path of least resistance and when there is a lot of resistance, it will even find its way through your previously dry concrete cellar walls.

It just so happened, that in the cases of the calls I received, the address folders contained the evidence to explain that the drowning cellars were not the

result of their neighbor's recently repaired septic systems. Looking at topography and soils, the surveyed plans, which, I was familiar with, I could see that water previously drained toward the wet cellar in one case. And, in that case, the nearby repaired system was not mounded and, so, there were no changes in circumstances.

In another instance, the two address folders had sufficient evidence to tell me that previous and existing topography drained away from the caller with concerns. It not only drained away, but also there seems to have been previous concerns about groundwater just sitting and collecting between the two properties, because the plan showed a "pre-existing swale". A swale is a slight depression, a barely noticeable ditch, which is designed to allow water to run to it; then follow it away from where you don't want water to collect. The soil logs also showed where the high groundwater was found and what type of soils were found. In this case, the leaching area of the septic system had been placed in a sandy area with tighter soils deeper down (more than six feet). However, where the groundwater was presently sitting in part of the yard, there happened to be another soil log. The now-wet area had not been used for the leaching area because under some sand, there were tight, silt-loam soils that drain very slowly.

In cases like this, with silt loam below the sand, it is possible, when copious amounts of water are added, as in the month of March, that the "bathtub effect" can happen. The rain water seeps down through the sandy soils until it hits the silty, tight soil. It hits and then it sits. If enough water continues to arrive, it will rise, filling up the "bathtub" of someone's back yard.

In addition to learning from the National Weather Service, if you'd like to get more involved in your really wicked local weather, check out this cool, informative weather data site at http://www.cocorahs.org/ ,where you can follow their blog, check out all kinds of data, or even become a member and call in precipitation reports yourself. Oh, how my father, a pilot and barometer watcher, would have loved this site! It will be fun to order one of their rain gauges and join as a member. It looks like we have someone reporting from Kingston and Hingham and Middleboro, leaving lots of room for "wicked local" data reporting.

If you are thinking of buying a home, visit your local board of health and see what you can learn from their address folders and their health agent. There's more

to understand than the house and the septic plan. The soils and topography tell a story also. It might even tell you what water will do when lots of it falls on that property. Will it drain, or will it sit? You need to know that before you buy.

Cathleen Drinan is the health agent for Halifax, Ma. You can contact her at 781 293 6768 or cdrinan@town.halifax.ma.us

Beach Water Safety 101

I admit it. Some things health agents must do are kind of fun; like wearing thigh-high waders into the ponds, listening to red winged blackbirds and scooping up samples of pond water. While most people are taking their coolers out of storage this time of year in preparation for picnics, health agents are gearing up for lab work. We wouldn't want our beach water samples to get heated up, now would we?

The approach of Memorial Day is my reminder to get ready for sampling all the public and semi-public beaches. My first samplings are thus the week before, so that we know it is safe. This sampling is one of many State mandated activities put in place to ensure the safety of the public. As with so many State mandates, it is not funded at the State level. The testing of the beach waters in Halifax is funded by our small budget. There is one exception to this. Halifax has two private beach associations. They pay for the testing of their beach's water for the summer season. As their health agent, I collect the sample for free and their fee pays for the lab work.

Funding concerns aside, making sure the water is safe is an admiral goal. Before such mandates for water testing existed, children often became sick after visiting the beach. We used to accept such occurrences as ear infections and occasional dysentery as part of summer, without knowing exactly why.

Each Tuesday morning, I will collect samples of beach water in clean bottles like those used for urine samples. The samples will be kept in a closed cooler on ice for the duration of my ride around town and back in the office until the courier from G & L Labs picks them up.

Accompanying the water samples is the paper work called the Chain of Custody. That was one of so many terms I found so strange sounding when I started as the health agent. Now, it makes perfect sense to me. The paper describes what I am passing along, where it came from, what size and type of container holds the samples, exactly what time I collected them and the time I completed the work. My signature testifies to my statements and holds me responsible for the truth of them. The courier also signs this paper with a date and time of pick up. A carbon copy is left with me. The "chain" continues to the lab. At all times and through all hands, whoever has "custody" of the sample is documented. At no point is there to be a break in the chain of custody. It is the legal and scientific way to ensure accountability.

My chain of custody paper states the samples are of fresh water and they will be tested for one thing only, as required by State law. They will be tested for E. coli. The presence of E. coli could indicate the proximity of a septic system leaking into the pond. There are other sources of this bacteria, though. It could indicate the presence of animal fecal matter, for instance. Sometimes, there is a high count of E. coli right after a heavy rain. Under these circumstances, the catch-basins which have been collecting garbage, organic matter, and street run-off and baking under warm temperatures, suddenly are flushed out. A plume will form, sometimes ten feet into the pond, and that plume can be full of bacteria. I am supposed to collect the sample from "the worst-case scenario" and, so, after a heavy rain, I collect from the area of these plumes.

Along with the chain of custody, I also fill out a field data report. The State wants to know the weather, the air and water temperatures and other field conditions such as number of swimmers, presence of trash, weeds and algae. Any of these conditions could

also affect the lab results and the information also paints a picture as to the overall condition of our beaches. It makes me sad every time I must write "trash". I will never understand the mentality that enjoys the beach and then trashes it. The most frequent find is piles of Bud Light, Marlboro packages, nips, bait containers and sometimes I find whole bags of trash stuffed into the bushes. Amazing.

I receive a fax from the lab about thirty-six hours after the samples leave my office. That fax is quickly flowed up by hard copies. When the levels of E. coli are unacceptably high, a sign is posted closing the beach until the testing indicates a once again acceptable level. With the help of our Highway Department, the sign is up and comes down very quickly, as needed.

We have made so much progress over the years in upgrading septic systems, it is rarely necessary to post any beach closings in Halifax due to E. coli. How ironic it is, then, to see our beaches closed so often due to cyanobacteria, a concern that did not exist when I began this job. Now, it is a large portion of my job! I hope this year is good one and hope the recent Alum treatment helps. While waiting for those results, I get to wear my waders and watch nature for one morning each week. I am fortunate, indeed.

Cathleen Drinan is the Health Agent for the Town of Halifax. She and the Board of Health welcome your comments and suggestions for this column. She can be reached at 781 293 6768 or at cdrinan@town.halifax.ma.us

7-14-18 For the Love of the Lakes!

We need your help two or three times a year. I am not kidding. If you can, for the love of the lakes volunteer an hour, two or three times year, you will have helped an important group succeed in its very important mission, that of making sure that an act of legislation from 1964 is doing what it is supposed to do. That legislation established the Central Plymouth County Water District. It has an advisory board and three commissioners. It is the advisory board that needs a few volunteers, so that we can have a quorum and represent the towns.

Lots of other people and organizations will do the heavy lifting but we need (desperately) a few people to come forward with this tiny effort to make possible the larger efforts and achievements of others.

When I first began the job as Halifax's health agent, it was clear to me the Monponsett Ponds were near and dear to the hearts of the residents. At the time, septic systems around the ponds were the big concern. Could we have a treatment plant to address that concern was the big question. At the very first meeting I had for the Monponsett Ponds, the Halifax town hall was packed.

That was the just the beginning of my education regarding the history of the Monponsett Ponds. As I stood before the caring crowd, every time I spoke the word "Pond", an elderly gentleman kept calling out "Lake!". While I had to get past this muddying issue of semantics, what was clear to me was that he loved those water bodies! He showed me photos of the 1940's, indicating beaches all along the shore. I now keep some vintage postcards nearby my desk as a reminder of the tourism that once existed there and those beaches! The real images of shores where you could sit and play, and picnic are crucial to the story because they used to exit but do not now because of an act of legislation in 1964, allowing the City of Brockton to build a dam, allowing the water to rise and hold it back to use for diversions to Silver Lake in Kingston. It would then be treated and sent to the city of Brockton.

While we have made enormous strides in septic system repairs and innovative treatments to protect the ponds and the cranberry bog owners have better practices for the environment including reduced use of phosphorous, Halifax and State departments and many watershed and environmental groups spend a ton

of time and money addressing the algal blooms and the widespread concern of the currently non-sustainable water use practices.

The blue-green algae (Cyanobacteria) problem is so visible and so discernable by our olfactory nerves, that it re-ignited concerns for the ponds about a decade ago. And for that we are grateful. However, there is more going on than meets the eyes and noses of residents. In fact, recent Alum treatments to the Monponsett Ponds have been so successful in binding the phosphorous feeding the cyanobacteria, it has created the clearest pond water many have seen in more than a decade.

We are still left with the lack of shores, intermittent flooding around West Monponsett, the lack of natural flow down Stump Brook because of the dam and the over-use of Silver Lake and the starving of the Jones River, to name just a few of the consequences of the 1964 legislature.

While that legislature was considered an emergency for Brockton, the dam is still there, and many surrounding towns and water bodies have their own current emergencies. At least the 1964 legislators knew enough to involve the surrounding towns. Their water bodies were involved and, if needed, the named towns could also benefit from this water supply.

Here is a portion of the 1964 legislation and why I need you:

"There is hereby established the Central Plymouth County Water District, hereinafter called the district, consisting of the city of Brockton and the towns of East Bridgewater, Halifax, Hanson, Kingston, Pembroke, Plympton and Whitman.

The city of Brockton, hereinafter called the city, for the purpose of increasing its water supply is hereby authorized to divert surplus flow as defined in section nine from Furnace Pond, situated in the town of Pembroke, and Monponsett Pond situated in the towns of Halifax and Hanson, into Silver Lake and thence to the city and the towns also supplied…

CHAP. 371. 261 the General Laws, nothing in this act shall be construed as preventing the normal use of the aforesaid Furnace Pond and Monponsett Pond for bathing, boating, fishing and other purposes…

The district shall be under the direction of a commission consisting of three commissioners, hereinafter called the commission, who shall be appointed by the

advisory board. One of said commissioners shall be a resident of the city of Brockton.

Any vacancy in the office of commissioner shall be filled by the advisory board within three months ACTS, 1964.— CHAP. 371. 259”

Only the commissioner representing Brockton needs to be a resident of Brockton. As for the advisory board, with the important task of appointing the commissioners, they can be from anywhere. If you care about these issues, please come forward for 2 to 3 hours a year, so that we can have a quorum. Although we have never had a representative from East Bridgewater, I think they would be happy to approve you as their representative. They, too, might one day need our water and you can help that happen! Hanson needed water while their water tower was being repaired. They are now highly motivated to have their own additional wells.

I need three people for 2 to 3 hours a year. Despite the complexity of the topic, you can keep it simple for you if that helps you to serve. You can all be from Halifax or Kingston or Hanson or Plympton, the towns surrounding the Monponsett Ponds and Silver Lake. But we need you, for Pete’s sake, for the Love of the Lakes!

Please contact me at crinan@town.halifax.ma.us or 781 293 6768

Cathleen Drinan is the health agent for Halifax.

Outreach & Education:
5. Sixth Grade Class Presentation & Student Essays *(5 out of 87 provided, additional essays can be provided upon request)*

3-8-19 Teaching is the Best Way to Learn

You know what they say about learning; the best way to learn is to teach. I had the pleasure of learning while teaching last week. I was invited by Halifax Elementary School's sixth grade teacher, Mrs. Lisa Whitney, to talk about the ponds and anything related to them. I decided to focus on two things, which is difficult with a complicated topic. First, I wanted them to know how much progress has been made with septic systems, especially around the ponds. So, I would tell them about the required testing for E. coli at all public and semi-public beaches from Memorial Day to Labor Day. Secondly, I wanted to talk about pollution and its effect on all the waters, as they are all connected.

Rather than just talk, talk, talk, I wanted to interact and have some fun. Explaining the weekly summer testing for E. coli allowed me to bring in props. Got to have props to keep the audience awake! I showed them my chain of custody form, my field data form, the cooler, the thermometer, the sample cup and my favorite barbecue tongs for holding the sample cup. Best of all, though, were the waders. After describing how to take the sample, (walking slowly, so as to not stir up the bottom, walking out to my knees and slowly dipping the sample cup down to about 6 to 12 inches below the surface, avoiding going near the bottom, over and back up again), I asked the class, "Would anyone like to put on the waders and demonstrate how to properly take a sample of pond water?" Almost everyone wanted to.

It was fun watching the students walk slowly into the invisible pond and dip the cup into the invisible water. (They had been listening!) Each student in the four classes smiled with this accomplishment. I think I met some future scientists and some actors!

Watching the students in the waders was a tough act to follow, so I had to take a deep breath and hope my pollution demonstration was not too lame. My props were a cafeteria tray (They have not changed in decades!) representing the ground, a blue piece of paper representing ground water and a cardboard egg case representing many things, such as a septic tank, or a septic system leaching area, or a whole pond.

Then, the class was invited to form a half circle around me to watch as I poured water into one section, saying "Water is very powerful. It will continue to flow as long as it needs to; nothing will stop it. This is like a heavy rain storm right

here in this corner but watch the water flow and fill all the other sections." Then the "rain storm" stopped.

Next, red dye was poured into one corner. It began to flow into the other sections all by itself without any assistance. I told the students that in public health we often hear the saying, "Sometimes Dilution is the Solution to Pollution." They liked that, exclaiming, "Hey, that rhymes!" I had no idea going into this demonstration how useful this phrase would be. As they asked questions, though, I could remind them of key words, such as "Sometimes" (What if a small amount of something was highly toxic?")

The spreading red dye showed the process of diffusion, where all the molecules move until stasis is achieved. I compared it to someone spraying perfume in one corner of the room and it smells really strong at first. Then it spreads to the rest of the room and the smell is not so strong. Stasis had been achieved. I told them the flowing red dye is what happens with pollution. It will spread as it joins the water. The more pollution there is, the less likely that any dilution can happen. The less pollution we add, the better chance dilution has.

As the red dye was slowly flowing, I added a little ground flax seed to the same corner where the dye was poured. It took off with the movement of the dye and flew from one end of the egg case to the other immediately! I asked the students to think of the flax seed as other pollutants, such as E. coli.

While we talked, they noticed something happening to the egg case. It was becoming saturated and the red dye was leaking out, even though not much had arrived on the surface at the other end of the case. The red dye was staining the blue paper representing the groundwater! This was a significant moment.

They were beginning to understand the concept of ground water and they had learned that day that Halifax's drinking water comes from wells tapping into ground water. Before they learned that, every class guessed our water came from the ponds. The second guess of every class was the water tower.

Some students knew about Brockton's use of the Monponsett Ponds.

Many students had been told the ponds are not safe for swimming.

I hope all eighty-seven students will talk to their parents about pollution and how preventing it protects our groundwater. We did talk about phosphorous feeding the algae and that people need to decide if it is worth it to use it on their

lawns. Children are not only learners; they are also great teachers, capable of transforming a whole society.

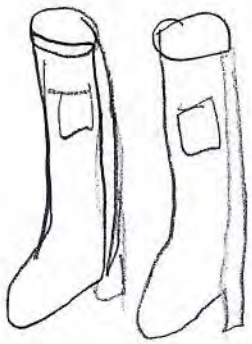
Thank you, Mrs. Whitney, for the invitation. It was an honor and a blast!

Cathleen Drinan is the health agent for Halifax, MA. She can be reached at 781 293 6768 or cathleen.drinan@halifax-ma.org

Jasmine Guimares

I learned more about how polution can ruin our lakes, The ground water, and can effect our health. The E. coli, which we have in our gut. Is in our lakes, and washing food items like lettuce, tomatos, and pasta, with the dirty E.coli water can harm us. We can get sick or die dive to it. Which is VERY scary. Especially when Cathleen Drinan's experiment leaked into our "Ground water". Thankfully our septic systems are high enough from the ground water. Not to mention they test the water every tuesday so I am a little more confident of our water supply.

But the boots felt wierd. Just wanted to put that out there.



Cadence Nobles Blue

During the presentation, Cathleen Drinan, a Health Agent on the Board of Health for Halifax, taught us about how our water gets polluted and how the polution can affect our lives.

Cathleen told us that if your septic tank gets too full, or springs a leak, the debris in the tank can leak into ponds, streams, etc., and pollute the water. Then, if you swim in the water you could get very very sick.

Cathleen did a demenstration, showing us the process of the water and debris leaking into the water source. She started by filling an egg carton with water to show the base of a septic system. She then added red dye and ground flaxseed to represent the debris in the septic tanks. As we let the water, dye, and flaxseed sit, it started to leak out of the bottom of the carton to represent how septic systems can pollute the water.

Overall, Cathleen did a great job to show us the pollution process.

Maddie Thorp Feb. 26th, 2019

The Demonstration from Cathleen Drinan

Cathleen Drinan, a health agent from the Board of Health for the town of Halifax, Mass came in and gave our class a demonstration of how pollution affects the water we drink.

Cathleen took an egg carton and poured regular water into it, then poured red dye into the egg carton filled with water. She explained how the red dye will spread all throughout the water, just like pollution will. She then put some ground flaxide ingredient in the water and red dye mixture to represent bad chemicals that can spread throughout the water.

When people swim and/or drink this water that has been polluted they can end up very sick.

I learned that things we do, even if we don't live near a water source, can change the water. This is a reason that people like Cathleen Drinan test Halifax's water sources.

2/26/19

Kathryn Arnold Color: Blue

I learned a lot thanks to Cathleen Drinan. She is a health Agent for the town of Halifax. She works for the board of health.

I learned that if your septic tanks leak into the water of lakes, rivers, or ponds. If health Agents didn't take water samples & people went swimming it could cause great harm. If you swim in the water before it was cleaned out you could end up sick & in the hostpital.

We observed Cathleen while She did a demonstration. She added water into a egg carton and the water spread on it's own with out it being mixed up. She added red food dye which represented the debris that is in the water.

We Can help protect the local ponds, lakes, & rivers by not polluting & using less chemicals when you are cleaning your toilets. Don't Polute!

Shawn Greene

I learned that faucites polute the water they come from fertilizes dish soaps and over stuff they help bad algerigas grow the town uses Alom which bounds with the faucites and brings them down to the bottom of the pond so they can't help the Algerigas grow in the water move it so people can swim in the water.

The secand thing I learned was E.Col ih water is bad the E.Col gets in the water by sectime leak and over things. It's bad for the drin water because it is very bad for the human body so we can't drink they try to get rid of E.Col by making sure septic tanks are safe and don't leak.

The third thing we did was an Exiperment showing with dirt and water that a little dirt or Polution can be filtered out but alote of dirt will Saturate and polute the ponds.

Scope of Services and Budget Breakdown

Attachment A
Scope of Services – Amended April 10, 2018

West Monponsett Pond Nutrient Management Project
17-05/319

Introduction:
The Monponsett Ponds, consisting of West Monponsett Pond and East Monponsett Pond, are located in Halifax and Hanson. The ponds are relatively shallow water bodies that serve several public interests including drinking water supply, agricultural (cranberry) water supply and discharge, fisheries and wildlife habitat (including habitat for three state-listed species), flood control and recreation. The shallow waters in the ponds combined with the warm water temperatures and high nutrient content make them very susceptible to cyanobacteria toxin blooms which have resulted in multiple beach closures and serious health concerns. Since 2008 the Massachusetts Department of Public Health has issued many public health advisories for the pond, forcing the Town to close the beaches to swimming and boating.

This project follows work funded by SWMI (2013 and 2015), EPA-WMOST Modeling (2014), NEIWPCC grants (2016), and an EPA Section 319 grant (12-02/319). In 2014, Monponsett Ponds and Stump Brook received priority project status as sponsored by the Massachusetts DER.

West Monponsett Pond is listed on the 2014 Integrated List of Waters as a Category 5 water body impaired for phosphorus, excess algal growth, and proliferation of non-native aquatic plants. This project will undertake in-lake sequestration of phosphorus as part of the remediation strategy to restore water quality to meet water quality standards. Tasks 2 and 3 have been already completed by the Grantee as part of in-kind match. The Grantee is the Town of Halifax.

Project Goals:
The goal of this project is to sequester the phosphorus in the lake sediment and reduce the concentration cyanobacteria that produce dangerous toxins through aluminum sulfate (alum) treatment.

Strategy:
Application of aluminum sulfate (alum) to remove phosphorus from the water column. Due to the poor buffering capacity of the pond sodium aluminate will be simultaneously applied during the treatment in order to maintain a proper pH in the pond during the treatment. Buffered alum treatments will be applied to the pond with application rates and timing to be determined following review by NHESP staff.

Targeted Pollutants and Waterbodies:
The pollutant of concern: phosphorus. The specific target waterbody for this project is West Monponsett Pond in the Taunton Watershed

Scope of Services:
The scope of services for this contract shall consist of the following tasks and deliverables as outlined below, consistent with the Grantee's technical proposal received on June 1, 2016 and as outlined in the RFR of April 1, 2016. In order for a deliverable to be considered complete under the contract, the deliverable must be completed in accordance with the contract specifications and contract schedule, must be approved by MassDEP.

Task 1: Quality Assurance and Project Evaluation
The project is covered under the Department's 319 Programmatic Quality Assurance Project Plan (QAPP), FFY 2015-2020, approved by US EPA on September 8, 2015. The Grantee or its designee will provide information as requested by the Department to facilitate evaluation and reporting of project success.
Deliverable 1:

- Using the Simple Method or equivalent (http://www.stormwatercenter.net/monitoring%20and%20assessment/simple%20meth/simple.htm) modeled results of anticipated pollutant load reductions achieved by BMPs implemented under this project, produced by the project designer, engineer, or other qualified person; AND
- Documentation of the BMP implementation work. Information to be supplied for each BMP includes BMP type, date of completed installation, targeted pollutant(s), size of targeted treatment area, and site maps.

Task 2: Permitting
Prepare and file Notice of Intent with the Halifax & Hanson Conservation Commission, and other local and state agencies as appropriate. Attend Public hearing and notify abutters.
Deliverables 2: Approved Orders of Conditions to conduct phosphorus inactivation treatment

Task 3: First Phase Buffered Alum Treatments – COMPLETED
Apply three low-dose buffered alum treatments (April-July 2015): for a total areal dose of approximately 4.9 g/m^2 throughout all areas greater than 4 ft. in depth (approximately 235 acres).
Deliverable 3:
Summarize and report on the results of the treatment and monitoring including phosphorus reduction. Outline findings and the feasibility of possible improvements/modifications. Quantify amount of phosphorus removed from the water column.

Task 4: Second Phase Buffered Alum Treatments – COMPLETED
Apply three low-dose buffered alum treatments (April-July 2016): areal dose of approximately 3.2 g/m^2 throughout all areas greater than 4 ft. in depth (approximately 235 acres).
Deliverable 4:
Summarize and report on the results of the treatment and monitoring including phosphorus reduction. Outline findings and the feasibility of possible improvements/modifications. Quantify amount of phosphorus removed from the water column.

Task 5: Third Phase Buffered Alum Treatments
Obtain all necessary permits. Apply buffered alum treatments to West Monponsett Pond. Application and timing of treatment will be approved by NHESP staff.
Deliverable 5:
Summarize and report on the results of the treatment and monitoring including phosphorus reduction. Outline findings and the feasibility of possible improvements/modifications. Quantify amount of phosphorus removed from the water column.

Task 5B: Fourth Phase Buffered Alum Treatments
Obtain all necessary permits. Apply buffered alum treatments to West Monponsett Pond. Application and timing of treatment will be approved by NHESP staff.
Deliverable 5B:
Summarize and report on the results of the treatment and monitoring including phosphorus reduction. Outline findings and the feasibility of possible improvements/modifications. Quantify amount of phosphorus removed from the water column.

Task 6: SCADA Feasibility and Design Memorandum at the Monponsett Pond System – COMPLETED
Conduct Supervisory Control and Data Acquisition feasibility and issue design memorandum on automating water flow controls at the dam to allow for a more constant flow and provide better flushing of the Pond.
Deliverable 6:
Summarize and report on the results of the feasibility study and design memorandum.

Task 7: Installation of Automated Water Flow Control
Obtain all necessary permits. Install automated water flow controls at the dam to allow for a more constant flow and provide better flushing of the Pond. Provide photodocumentation of the facility and equipment.
Deliverable 7:
Summarize and report on the results of the construction, operations and maintenance. Provide photodocumentation of the installation.

~~**Task 8: Design and Installation of Alum Treatment Facility**~~
~~Obtain all necessary permits. Install an alum injection pump feed system, pumphouse or similar, equipment, supplies, etc. and as appropriate for continued seasonal metered alum application in West Monponsett Pond. Provide photodocumentation of the facility and equipment.~~
~~**Deliverable 8:**~~
~~Summarize and report on the results of the design, construction, treatment and monitoring including phosphorus reduction. Quantify amount of phosphorus removed from the water column. Provide photodocumentation of the facility and equipment. Develop guidance and implement an operation and maintenance plan that includes the following elements: identification of owners of the BMPs, identification of the party or parties responsible for operation and maintenance of the BMPs, schedule for inspection and maintenance, list of routine and non-routine maintenance tasks to be performed, source(s) of funding for long term operation and maintenance of the BMPs, extending for the life of the BMPs, and a map showing the locations of the BMPs.~~

Task 9: Outreach and Education
Share updates and results of the alum treatment program with the public during Board of Selectmen Meeting(s) and through presentations during Monponsett Watershed Association (MWA) Meetings, newspaper, facebook, interviews with local south shore radio station. Additionally an educational flyer will be developed and distributed as part of this project. The flyer will be a one page double-sided document that will include a project summary, background of the project and project timeline. Copies will be made available at Town Hall and at the Board of Health.
Deliverable 9: A report summarizing outreach and education activities undertaken for this task, with copies of all educational and outreach related materials and a report describing distribution, results, follow-up, and recommendations resulting from the task.

Task 10: Reporting and Project Oversight
The Grantee will submit the following deliverables to MassDEP in accordance with the Milestone Schedule in Attachment C:

a: Quarterly progress reports will be submitted to the 319 Project Officer. Quarterly reports must be submitted by email in a format compatible with the Department's software (MS Word unless otherwise specified). These reports must contain a summary of all work completed, by task and as a percentage of each task completed, during the reporting period; and planned activities for the next quarter.

b: The Invoice, Attachment for DM/DWBE Reporting, and Match Certification forms should be signed by the authorized signatory, scanned, and submitted via email to the Department's Contract Manager. Hard copies are not required. Supporting documentation can also be submitted via email to the Department's Contracts Manager.

c: Quarterly reports described above must be submitted to the Department within 15 days following the end of the reporting quarter (i.e.; by January 15th, April 15th, July 15th and October 15th of each year).

d: A draft final report shall be submitted to the 319 Project Officer for review and comment at least two (2) months prior to the contract end date. This report must include a description of all activities undertaken as part of the project and a summary of the project.

e: Two complete hard copies of the final report and three CDs with electronic versions of the final report will be submitted to the Department by the project end date. The electronic report shall be authored in MS Word and then converted to tagged PDF files for compatibility with the Department's internet web site. CDs should include both Word and PDF versions of the report and other project deliverables as appropriate.

Any files that are intended for publication on the MassDEP web site must comply with accessibility guidelines found at www.mass.gov/accessibility

Deliverable 10:

1. Quarterly progress and fiscal reports.
2. Draft and Final Report.

Additional Contract Conditions

1. Work undertaken as part of this grant project must exceed the requirements of the NPDES MS4 permit, and cannot be credited toward meeting the requirements of that permit.

2. All materials, software, maps, reports and other products produced through this contract shall be considered in the public domain and thus available at the cost of production. If GIS products are produced, a copy of any spatial data developed and full meta-data documentation must be provided as part of the project deliverables. A template for meta-data documentation is available from MassGIS. Data should be provided in either an ESRI file geo-database or shapefile.

3. During the project, title to any and all real and personal property, equipment and accessories purchased and used for the project scope of work and funded in whole or part by this contract shall be in the name and control of the Grantee.

4. After termination of the project, the manner of use and disposition of any equipment and accessories purchased and used for the project and funded in whole or part under this contract shall be determined by the Department.

5. Grantees must immediately notify the Department of the loss or reassignment of any key employee or subcontractor identified in the proposal, and the Department requires that a replacement employee or subcontractor be assigned within 60 days. The Department reserves the right to terminate the contract if the Grantee fails to replace a key employee or subcontractor within this time frame or to substitute appropriately qualified key employee.

6. Any changes to the contract scope of work or budget categories must be approved in writing by the Department. Requests for contract scope or budget modifications must be submitted in writing to the 319 Project Officer for review and approval.

7. The award of this Grant by the Department does not constitute a permit or any other approval that may be required for the implementation of the project funded by the Grant. The grantee shall timely obtain, and comply with, all federal, state and local permits and approvals required for the project.

8. The Department reserves the right to approve the selection of all consultants or subcontractors.

9. For any BMP installation funded under the 319 program, written certification that the system has been installed according to engineering and design specifications will be required from the designer or supplier of the technology. The certification must occur prior to the system being covered, buried, or otherwise made inaccessible, and shall occur in advance of release of payment for the system by the Department.

Public Awareness Terms and Conditions

- Prior written approval from the Department is required before material derived from the deliverables received under this Agreement is presented for publication or posted on the internet. An Acknowledgment of Support must be made in connection with the publishing or Internet posting of any material based on or developed under this Agreement. The acknowledgment will be in the form of a statement substantially as follows: “This project has been financed with Federal Funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (the Department) under an s. 319 competitive grant. The contents do not necessarily reflect the views and policies of EPA or of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.”
- Statements to the press are authorized as long as proper acknowledgment is given to the Department and EPA.
- Announcements: The grant recipient agrees that announcements through the web or print materials for Workshop, conference, demonstration days or other events as part of a project funded by a 319 assistance agreement shall contain a statement that the materials or conference has been funded by the Massachusetts Department of Environmental Protection and the United States Environmental Protection Agency.
- Public or Media Events: The Recipient agrees to notify the MassDEP and EPA Project Officers of public or media events publicizing the accomplishment of significant events related to construction projects as a result of this agreement, and provide the opportunity for attendance and participation by state and federal representatives with at least ten working days notice.
- Limited English Proficiency Communities: To increase public awareness of projects serving communities where English is not the predominant language, recipients are encouraged to include in their outreach strategies communication in non-English languages. Translation costs for this purpose are allowable, provided the costs are reasonable.

Attachment B
Project Budget – Amended April 10, 2018

West Monponsett Pond Nutrient Management Project
17-05/319

Expense Items	**s.319 Amount**	**Amendment**	**Non-Federal Match**	**Total Amount**
Salary - By Title and salary range: Town Administrator $65-$70/hr Health Agent $30-$35/hr Conservation Volunteers $29/hr			**$ 19,185[1+2]**	**$ 19,185**
Subcontractual Services:				
Engineering Services	$ 24,000	$ 24,000	$ 8,000[3]	$ 32,000
Phosphorous Inactivation Treatment	$174,000	$301,500	$149,570[4+5]	$451,070
~~Alum Treatment Pump and Facility~~	$127,500			
Feasibility and Design Memorandum for Automated Water Controls			$ 72,450[6+7]	$ 72,450
Automated Water Controls Install			$ 35,000[8]	$ 35,000
Permitting and Permit Requirements				
Grant Management	$ 6,000	$ 6,000	$ 4,000[9]	$ 10,000
Subtotal:	**$331,500**	**$331,500**	**$269,020**	**$600,520**
Other:				
Travel:				
Totals:	**$331,500 53%**	**$331,500 53%**	**$288,205 47%**	**$619,705 100%**

The Disadvantaged Business Enterprise, (DBE) Program "Fair Share" goals for the project are: $21,070 for D/MBE (3.4%) and $23,549 for D/WBE (3.8%). Firms utilized in Federally Assisted Projects must be certified as either an MBE or WBE *and* a DBE.

The Department will retain 10% of the total maximum obligation of the 319 grant funds or the final invoice submitted by the Grantee, whichever is greater, until all contract provisions are satisfied and final reports and other products are delivered and accepted. This 10% retainage shall be reflected on each invoice submitted by the Grantee and will be cumulative in the amount of $33,150 (10% of the contract amount.

Non-Federal Match will be:
[1] Local officials, conservation volunteers, and other watershed stakeholders: $16,785 as per proposal received 6/1/2016
[2] Previous in-kind match of $2,400 for the FY2014 SWMI Grant)
[3] Town funds as per proposal received 6/1/2016: $8,000
[4] Past alum treatments totaling $90,380 (Town funds paid 3/2015 through 1/2017)
[5] Town funds as per proposal received 6/1/2016 and email received 5/17/2017: $41,215 and $17,975 respectively
[6] FY2014 SWMI grant: $57,450
[7] Town of Halifax cash match paid for 2014 SWMI grant: $15,000
[8] Automated water controls installation committed by the City of Brockton on 5/5/2107: $35,000. This cost is not required of the Town of Halifax if the City of Brockton fails to install the controls.
[9] Town funds as per proposal received 6/1/2016: $4,000
Subtotal Non-Federal Match: $270,230

Scope and budget amended 5/18/2017 to provide a more intensive and sustained approach toward addressing the phosphorus issues in Monponsett Pond. Approved M. Harper, 5/18/2017
Scope and budget amended 4/10/2018 to provide a more intensive application of alum to address lingering phosphorus issues in Monponsett Pond. Approved M. Harper, 4/10/2018

Attachment C
Milestone Schedule

West Monponsett Pond Nutrient Management Project – Amended April 10, 2018
17-05/319

Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1: QAPP	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2: Permitting	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
3: Phase 1-COMPLETED																								
4: Phase 2 – COMPLETED																								
5: Alum Treatment - West Pond	X	X	X	X																				
5B: Alum Treatment - West Pond																X	X	X	X	X				
6: Feasibility and Design Memorandum – COMPLETED																								
7: Install Automated Flow Controls	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
8: Alum Treatment Facility.			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
9: Outreach	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10: Grant Management & Reporting				X			X			X			X			X			X			X	X	X